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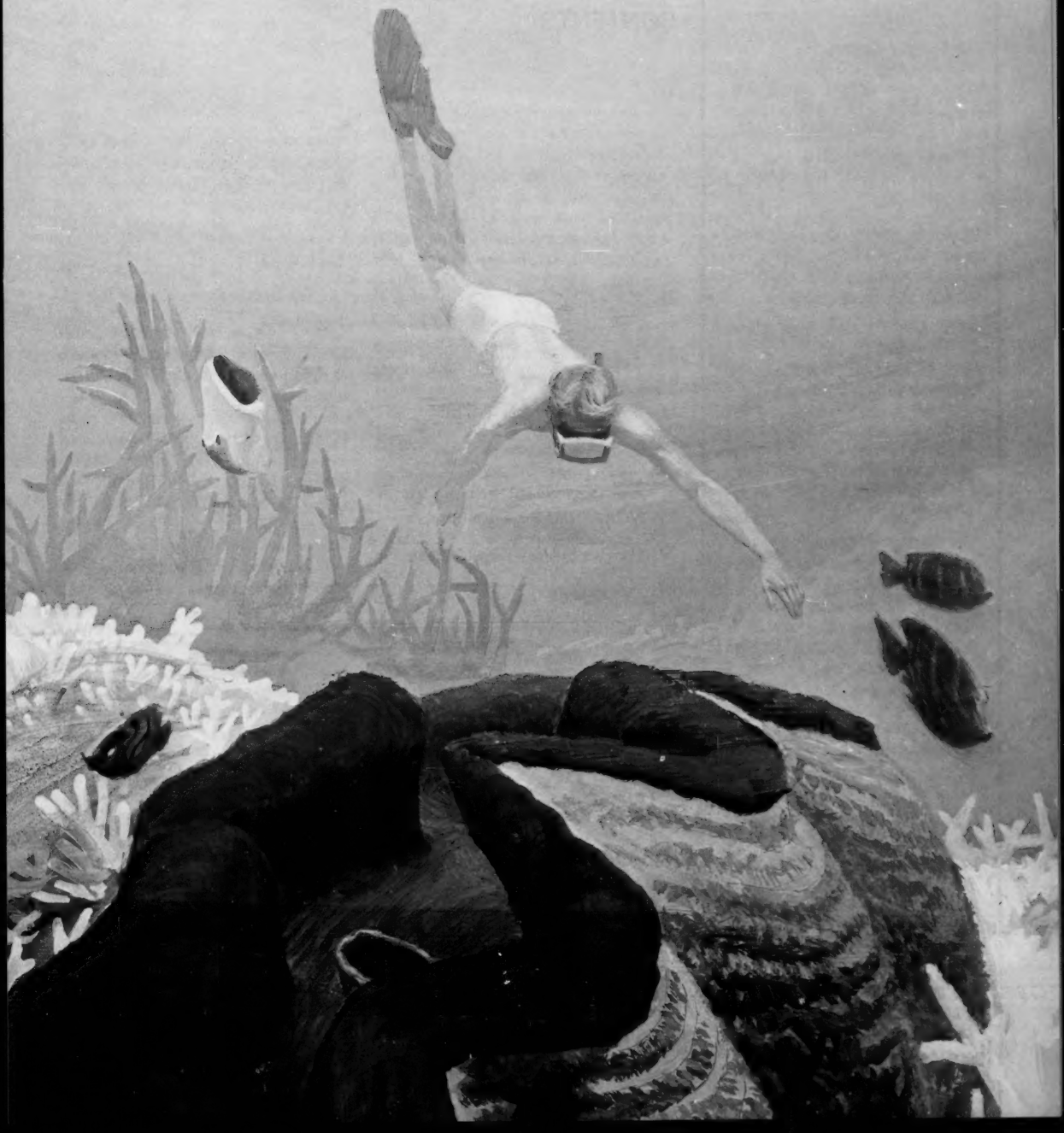

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MFR PAPER 1181

U.S. Observers Board Japanese Trawl Vessels in Bering Sea

MARK MILLER, LARRY NELSON, ROBERT FRENCH, and STEPHEN HOAG

INTRODUCTION

The Bering Sea, with its vast continental shelf area, is one of the largest of the world's seas. It is extremely rich in benthos, or bottom-dwelling organisms. The shelf area covers about 1 million km^2; in the central and eastern sectors it extends some 600 km offshore (Fig. 1).

Because of its abundance in fish fauna, this area has attracted much interest by foreign fishing fleets with a remarkable increase in fish landings in recent years. In 1971 total catch was nearly 2 million metric tons. Japan and the Union of Soviet Socialist Republics (USSR), with their large modern fishing fleets, harvest most of the catch now landed. The Republic of Korea entered the fishery in 1967 but together with the United States and Canada takes less than 1 percent of the harvest. The important species in the catch are walleye (Alaska) pollock, *Theragra chalcogramma*; yellowfin sole, *Limanda aspera*; Pacific cod, *Gadus macrocephalus*; herring, *Clupea harengus pallasi*; flathead sole, *Hippoglossoides elassodon*; rock sole, *Lepidopsetta bilineata*; and Pacific ocean perch, *Sebastes alutus*.

Of considerable importance to United States and Canadian fishers is the Pacific halibut, *Hippoglossus stenolepis*, the abundance of which has decreased in recent years to the point where it has become unprofitable for North Americans to fish for the species in the Bering Sea. Although halibut are taken in trawls, Japan has agreed, with minor exceptions, not to retain trawl-caught halibut east of long. 175°W. Japanese fishers must, therefore, return to the sea halibut taken incidentally in the trawl fishery. Because of the decline in the catch of halibut by setlines (the principal gear used by North American fishers) and because of the possible deleterious effects of trawling on stocks of halibut, king crab, *Paralithodes* spp., and snow (Tanner) crab, *Chionoecetes* spp., the United States pressed for a program to place U.S. scientists and technicians aboard Japanese fishing vessels.

The objective of this program was to determine the incidence of halibut and crab in trawl catches. These data have been important in devising corrective procedures to reduce the incidental catch of crab and halibut.

From March 1973 through 1974, by agreement with the Government of Japan and the Japanese fishing companies, the United States Government, in a cooperative effort by the National Marine Fisheries Service, International Pacific Halibut Commission (IPHC), and Alaska Department of Fish and Game, placed qualified observers aboard Japanese groundfish vessels operating in the eastern Bering Sea. This report reviews the background and highlights the results of

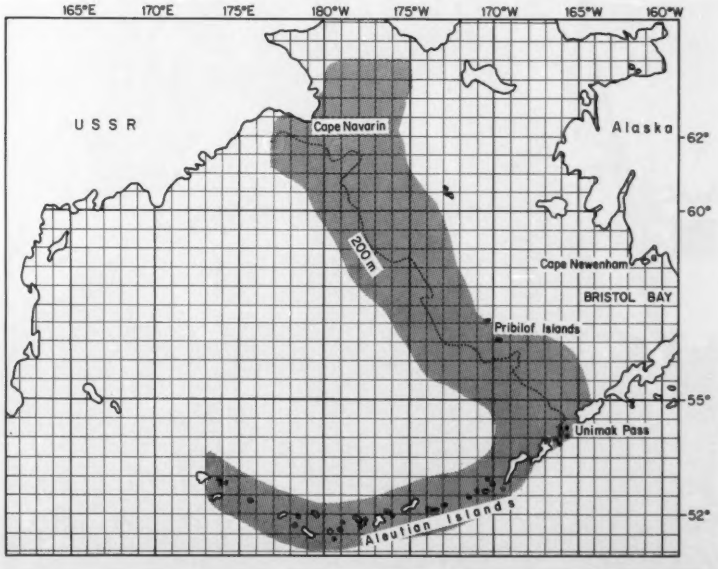

Figure 1.—Fishing area of Japanese groundfish fleet.

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this first comprehensive foreign fisheries observer program in the Bering Sea.

THE JAPANESE BOTTOMFISH FISHERY

Early History and Products

The history of the Japanese bottomfish fishery in the eastern Bering Sea predates World War II (Chitwood, 1969). During the 1930's Japan conducted a relatively minor fishery—walleye pollock was the target species for conversion to fish meal and oil. In the early 1940's before the start of World War II, another mothership-type operation was conducted with emphasis on yellowfin sole, frozen for human consumption. Both of these fleets operated in the southeastern Bering Sea and were interrupted by World War II.

After World War II, the fisheries policy of the Allied Occupational Forces restricted Japanese fishing to waters around Japan. With the signing of the Peace Treaty in 1952, fishing restrictions were removed and Japan resumed fishing for groundfish in the eastern Bering Sea in 1954. The develpment of these operations may be divided into three periods (1954-57; 1958-63; 1964 to present) according to target species, method of processing, and expansion of fishing grounds.

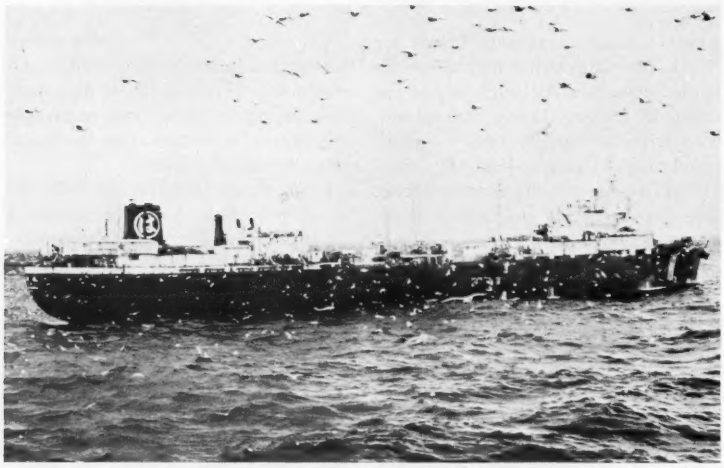


Figure 2.—Mothership *Soyo Maru*, 12,950 gross metric tons.

Figure 3.—Unloading a cod end aboard the mothership *Soyo Maru*.

During 1954-57, yellowfin sole (for the frozen food market) was sought off Bristol Bay between August and October. The total catch of all flatfish amounted to 24,000 metric tons in 1956 and 1957.

During 1958-63, an expansion of the fishery occurred throughout the Bering Sea with a diversification of target species. In the eastern part and later in the central part of the Bering Sea, yellowfin sole and arrowtooth flounder, *Atheresthes stomias*, were taken for the fish meal market. Catches peaked in 1961 at 456,000 metric tons but then declined greatly by 1963 because of overfishing by Japan and the USSR. By 1960 sablefish (black cod), *Anoplopoma fimbria;* Pacific ocean perch, Pacific cod; walleye pollock; and herring were being taken (for the frozen food market) north of the eastern Aleutian Islands.

Under terms of the International North Pacific Fisheries Commission (INPFC) established in 1953, Japan abstained from fishing halibut east of long. 175°W. In May 1963, however, halibut in the eastern Bering were removed from the list of species qualifying for abstention. Japan participated in the setline fishery for halibut that year and caught about 2,100 metric tons. Catches have since been reduced; after 1968 Japan has not fished for halibut east of the abstention line. As stated earlier, Japan agreed not to retain halibut taken in trawls east of long. 175°W, but Japan's land-based dragnet fishery does retain halibut west of long. 175°W.

The expansion of Japan's eastern Bering Sea fisheries after 1964 and the status of resources are described by Pruter (1973). During those years walleye pollock became the target species and in recent years constituted over 80 percent by weight of the total groundfish catch. Changes in fishing and limitations in the data make it impossible to judge how well the catch-per-unit-effort values for Japan's

fisheries reflect actual changes in abundance of various species. The abundance of some species, such as yellowfin sole and Pacific ocean perch, have declined and under uncontrolled fishing probably will remain below optimum levels.

The catch of walleye pollock by Japan greatly increased, primarily because of the development of the technology of preparing "surimi," a semi-processed wet fish protein (Miyauchi, Kudo, and Patashnik, 1973). This product is prepared aboard factory ships from pollock and other species; it is then frozen and returned to Japan for preparing "kamaboko"—a Japanese-style fish cake (Okada, Miyauchi, and Kudo, 1973). Although the frozen surimi industry in Japan started in 1960, it expanded greatly when equipment to produce surimi was installed aboard factory ships operating in the North Pacific Ocean and Bering Sea (Sakai, 1969). Because a major portion of the entire Japanese fish catch is processed into "kamaboko" products, the Bering Sea pollock fishery has assumed increased importance in the Japanese fisheries. Fishing for pollock was conducted mainly along the continental slope in the eastern Bering Sea in all seasons; in summer and fall the fleet increased its fishing in northern areas between the Pribilof Islands and Cape Navarin.

Figure 4.—Typical catch, composed of 90 percent walleye pollock, and 10 percent snow crab, flatfish, and miscellaneous species.

The Fishing Fleet

Four types of bottomfish fleets are licensed by the Fisheries Agency of Japan to fish in the Bering Sea. These are the mothership fishery, independent stern trawlers (North Pacific trawl fishery), the land-based dragnet fishery (which is only licensed to fish waters west of long. 170°W), and the North Pacific longline-gillnet fishery. Support vessels include a variety of refrigerated transports, cargo ships, and tankers (Chitwood, 1969). Observers sampled in the eastern Bering Sea on two types of vessels—motherships and factory stern trawlers. Photographs taken by U.S. observers of some of the vessel types and sampling methods are shown in Figures 2-8. Dickinson (1973) also has an excellent series of photographs of the Japanese fleet.

For the fishing fleets that fish only in

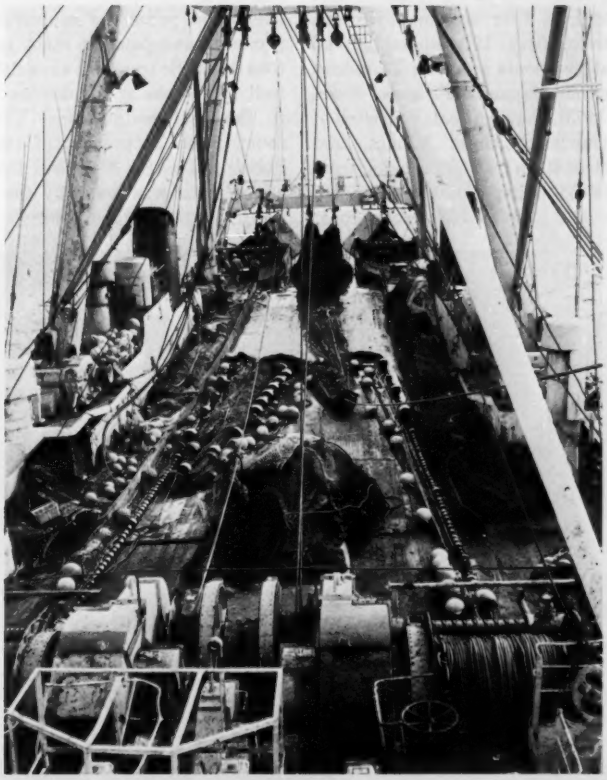


Figure 5.—Hauling net aboard the independent stern trawler *Zuiyo Maru*, 3,860 gross metric tons.

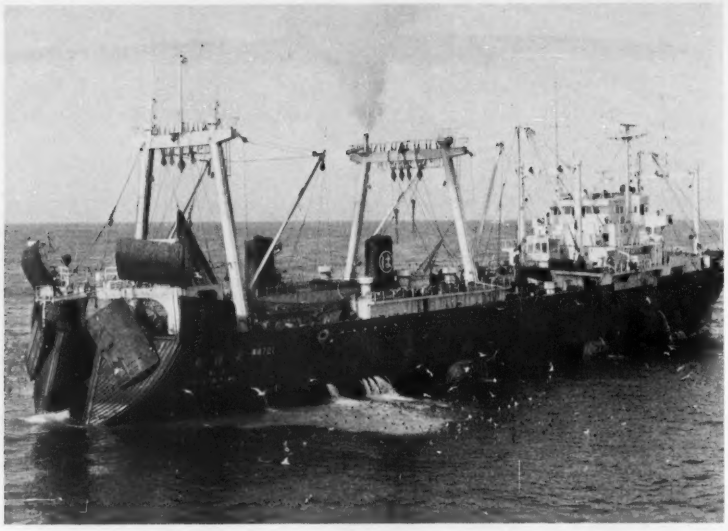


Figure 6.—Independent stern trawler *Tenyo Maru*, 4,220 gross metric tons.

the eastern Bering Sea (mothership, North Pacific trawl, and longline-gillnet fisheries), about 71 percent of the catch in 1971 was made by the mothership fleet; 12 motherships and 206 catcher boats landed 1.25 million metric tons (Japanese Fisheries Yearbook, 1973). Catcher boats consisted of pair trawlers, Danish seiners, and dependent stern trawlers ranging from 30.5 to 58 meters (100-190 feet) in length and 150 to 500 gross tons. Catcher boats make deliveries to the mothership one to several times daily, depending on catcher boat type, where the catch is processed into various fish products. Independent stern trawlers (North Pacific trawlers) have fishing as well as processing capabilities similar to those of motherships. They accounted for 28 percent of the 1971 Bering Sea catch. Less than 1 percent of the catch was made by the North Pacific longline-gillnet fishery.

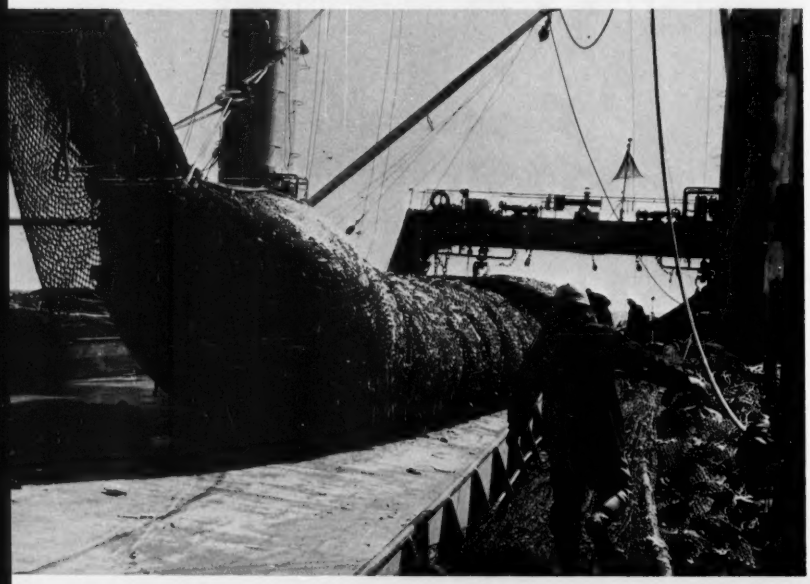


Figure 7.—Estimated 100-metric ton catch of walleye pollock coming aboard independent stern trawler *Yamato Maru*.

In past years the trawl fleet operated in the southeastern Bering Sea near Unimak Pass in the winter, although the fleet extended northwest of the Pribilof Islands during other parts of the year (Fig. 9). Most trawling operations are located along the continental slope and outer shelf areas and have recently expanded northwestward to off Cape Navarin on the Siberian coast. Limited fishing is also conducted along the Aleutian Islands. Fishing is carried out in the Bering Sea during all months of the year, although effort varies by season. A continuous stream of transport ships renew basic provisions of food and fuel for the fishing fleet biweekly and carry processed fish to Japan. Each vessel fishes approximately 10 months out of the year and spends the remaining time en route to and from the fishing grounds and in drydock for refitting and repairs.

THE U.S. OBSERVER PROGRAM

Background and Purpose

Landings of halibut by U.S. and Canadian vessels fishing in the eastern Bering Sea have decreased drastically the past few years. (The halibut fishery is managed by the International Pacific Halibut Commission (IPHC) for the United States and Canada.) From a catch of nearly 5,000 metric tons in 1963 by 104 setline vessels, the catch declined to less than 200 metric tons taken by 10 vessels in 1973. The IPHC contends that the initial decline of the stock was caused by excessive setline fishing by Canada, Japan, and the United States allowed under the quotas established by INPFC (Skud, 1973). Further decline was precipitated by the incidental trawl catch. The large incidental catch in recent years negated restrictions placed on the setline fishery, and reductions in incidental catches are required before any major increase in catch can be expected in the setline fishery.

Japan estimated the incidental catch of halibut at about 1.5 million fish in 1969 (November 1968 through October 1969), but the United States contended that Japan underestimated the catch of

halibut (Fukuhara and Worlund[1]), IPHC[2]. Differences between estimates were primarily due to methods of interpolating the incidental catch in areas and seasons where data was not available. The observer program resolved most of the differences in estimates and more clearly determined the incidental catch in Japanese landings. In 1972, U.S. observers were permitted aboard Japanese vessels for a limited period during the summer. During the 1972 annual meeting of INPFC, an expanded observer program was proposed for 1973. This program, subsequently approved by Japan in January 1973, involved the placement of two observers on each of two motherships and one observer on each of two independent stern trawlers during each quarter of the year. The observation periods were to be for approximately one month. This same type of program was also approved from 1974.

Primary objectives of the groundfish observer program are to: 1) determine the magnitude of the incidental catches of halibut and crab; 2) estimate halibut and crab mortality from trawling operations and handling on the deck of the vessel; 3) obtain biological information on halibut and crab and on target species (pollock and flatfish); and 4) collect statistics on catches.

Observers were provided by the Alaska Department of Fish and Game (11), International Pacific Halibut Commission (8), National Marine Fisheries Service (27), and in one case by the Fisheries Agency of Japan (Table 1). With the exception of the observer from Japan, all observers were trained in species recognition, sampling procedures, and techniques of data collection at the Northwest Fisheries Center of the National Marine Fisheries Service in Seattle. They were sent via commercial aircraft to Tokyo, Japan, where briefings were held with representatives of the Fisheries Agency of Japan and the fishing companies. Transportation to and from the fishing vessels in the Bering Sea was usually via supply vessels although sometimes the schedule of the observer's trip coincided with the departure or arrival of the actual fishing vessel to which the observer was assigned.

Figure 8.—Dumping the walleye pollock catch below deck on independent stern trawler *Yamato Maru*.

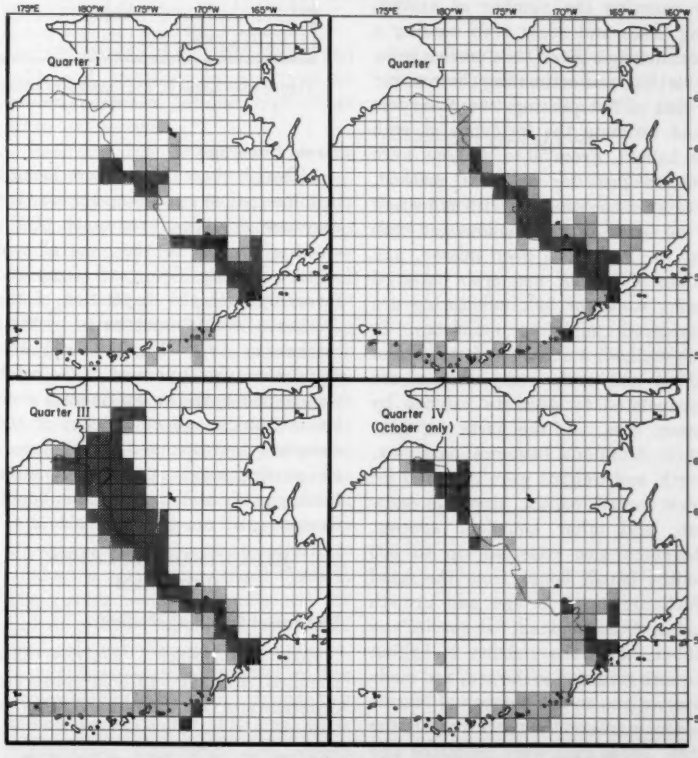


Figure 9.—Groundfish catch (by 1°x½°blocks) of the combined Japanese mothership and stern trawl fishing fleets, by quarters, 1972 (quarter IV includes catches through October only); light shaded blocks = less than 3,000 metric tons; dark blocks = greater than 3,000 metric tons.

[1]Fukuhara, Francis M., and Donald D. Worlund. 1973. Incidence of halibut and Tanner crab in catches by the eastern Bering Sea mothership trawl fishery and independent trawlers. Unpublished manuscript on file at the Northwest Fisheries Center, National Marine Fisheries Service, NOAA, Seattle, WA 98112.

[2]International Pacific Halibut Commission. 1973. The estimated incidental catch of halibut by Japan in the eastern Bering Sea and its effect on the North American setline yield. Unpublished manuscript.

Methods of Collecting Data

Sampling methods were designed to estimate the incidence of halibut and crab and to procure biological data on species in the catch. Although sampling designs aboard the vessel varied due to differences in vessel layout and processing procedures, two basic methods were used. A series of random basket samples were taken daily at different stages of a haul or bin emptying period, prior to any presorting. After each basket was weighed, individual species were sorted, counted, and weighed. Up to 2 tons of catch were sampled daily in this manner. The primary disadvantage of basket sampling was that a relatively small part of the catch was sampled. Relatively scarce species such as halibut frequently never appeared in basket samples, although they were observed in the fish bins.

A second method was to monitor the conveyor belt that transports the catch from the unloading bin to the factory. By counting the number of halibut, king crab, and snow crab passing a point during a given time period, prior to sorting, and estimating the number of tons of fish passing, the observers could estimate the incidence of crab and halibut. From 50 to 150 tons were sampled per day by this method. Because of the volume of fish and speed of the conveyor belt, halibut and crab may at times have been missed, and counts of halibut and crab obtained during conveyor belt monitoring are considered minimum estimates. In each method, numbers and weights of halibut and crab from samples are extrapolated to estimate catches by season, area, and the particular gear fished. Additional biological data (sex, length, and weight) were obtained for target species, halibut, king crab, snow crab, and other abundant species. Observers also collected up to 500 otoliths (small bones from the head which are used in age and growth studies) from dominant fish species and halibut, noted the viability of halibut and crab returned to the sea, and made observations on the number of marine mammals around the vessels and in the catch. These data were tabulated and analyzed through automatic data processing procedures at the Northwest Fisheries Center.

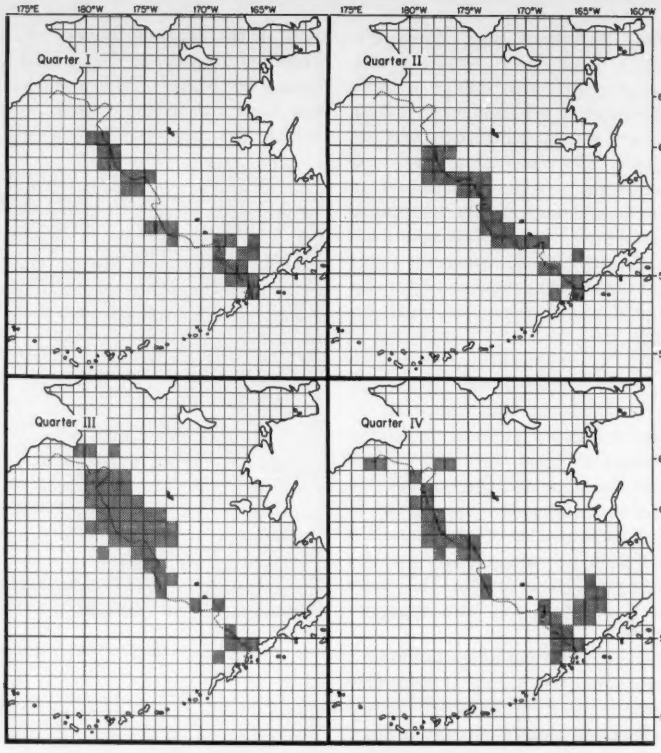


Figure 10.—Areas (1°x½° blocks) in which samplers were aboard Japanese motherships and stern trawlers, by quarter, 1973-74.

Areal Coverage

Although observations were lacking in some critical months and areas, the coverage extended over much of the trawling areas in the central and eastern Bering Sea, and compared favorably with the disposition of the Japanese fleet as represented by their catches in 1972 (Figs. 9 and 10). Approximately 97 percent of the catch was landed near the continental shelf 200-m isobath and 89 percent of the sampling days occurred there. Names of participating vessels, Japanese fishing companies, and the number of days sampled are given in Table 2.

RESULTS OF OBSERVER PROGRAM

Incidental Catch of Halibut

Hoag and French[3] analyzed data supplied by the 1973-74 observer program and the Fisheries Agency of Japan. These data were used to estimate the incidental catch and examine the difference in incidental catch by area, month, and gear type. Results of this work showed the highest incidence of halibut occurred from December to May along the shelf from the eastern Aleutian Islands near Unimak Pass northwestward to the Pribilof Islands—where the target species were pollock and yellowfin sole. Incidence values averaged about five halibut per metric ton of total catch. Incidence for other months and areas was less than one halibut per metric ton of catch. The average incidence of halibut for all quarters combined was slightly higher in catches by motherships (2.2 halibut per metric ton) than by independent stern trawlers (1.9 halibut per metric ton).

Average weights of halibut were generally between 0.5 and 10 kg and were higher in summer than winter. Those taken on independent stern trawlers averaged 2.71 kg; those taken by mothership catcher boats averaged 1.29 kg. Most of the halibut ranged in

[3]Hoag, Stephen H., and Robert French. 1974. The incidental catch of halibut by Japanese trawlers in the Bering Sea. Unpublished manuscript on file at the International Pacific Halibut Commission, Seattle, Wash.

Table 1.—Sampling assignments of observers on Japanese groundfish vessels in 1973-74.

Name	Organization	Vessel
D. Holland	NMFS	*Gyokuei Maru*
R.L. Carlson	NMFS	
S. Hoag	IPHC	*Soyo Maru*
R. Carlson	NMFS	
D. Peacock	IPHC	*Tenyo Maru*
L. Nelson	NMFS	*Yamato Maru*
L. Gwartney	ADFG	*Tsuda Maru*
P. Tata	ADFG	*Gyokuei Maru*
Y. Takahashi	JFA	
J. Garrison	NMFS	*Ohtori Maru*
G. St. Pierre	IPHC	*Hoyo Maru*
L. Landrie	IPHC	
H. Shippen	NMFS	*Soyo Maru*
P. Werdal	NMFS	
P. Novak	ADFG	*Gyokuei Maru*
C. Shimada	ADFG	
S. Moberly	ADFG	*Zuiyo Maru*
I. McGregor	IPHC	*Akebono Maru*
R. Bakkala	NMFS	*Kashima Maru*
P. Werdal	NMFS	
D. Daisy	ADFG	*Rikuzen Maru*
K. Roberson	ADFG	*Tenyo Maru*
L. Nelson	NMFS	*Soyo Maru*
G. Robinson	NMFS	
K. Niggol	NMFS	*Kashima Maru*
T. Dembski	NMFS	
D. Holland	IPHC	*Koyo Maru*
B. Barrett	ADFG	*Tenyo Maru*
J. Mason	NMFS	*Soyo Maru*
R. Bakkala	NMFS	*Chikubu Maru*
W. Bergmann	ADFG	*Gyokuei Maru*
R. Carlson	NMFS	
G. Peltonen	IPHC	*Haruna Maru*
C. Sims	NMFS	*Soyo Maru*
D. Misitano	NMFS	
M. Miller	NMFS	*Hoyo Maru*
T. Chestnut	NMFS	
J. Ploeger	NMFS	*Gyokuei Maru*
E. Kato	NMFS	
P. Werdal	IPHC	*Ohtori Maru*
A. Quimby	ADFG	*Akebono Maru*
R. Bakkala	NMFS	*Tenyo Maru*
R. Major	NMFS	*Soyo Maru*
B. Patten	NMFS	
E. Dawley	NMFS	*Kashima Maru*
R. McNaughton	IPHC	
K. Florey	ADFG	*Haruna Maru*

[1]ADFG = Alaska Department of Fish and Game.
JFA = Japanese Fisheries Agency.
IPHC = International Pacific Halibut Commission.
NMFS = National Marine Fisheries Service.

Table 2.—Names of vessels, Japanese fishing companies, and days sampled by U.S. scientists and technicians[1], March 1973-December 1974.

Company	Vessel type and name	Observer trips on vessel	Catcher boats PT[2]	DS[3]	DST[4]	Days sampled by quarter 1973 I	1973 II	1973 III	1973 IV	1974 I	1974 II	1974 III	1974 IV
	Mothership												
Nippon Suisan Kaisha	*Gyokuei Maru*	1	8	1		23							
		2	8	7	1		13	31					
		2	12	12	2						27	25	
Nippon Suisan Kaisha	*Kashimi Maru*	2	6		2				27	21			
		1	6		1								31
Taiyo Gyogyo	*Soyo Maru*	5			10	23	1	29	14	27	37		30
		1			9						27		
Hokuyo Suisan	*Hoyo Maru*	2	14	7				15				29	
	Independent stern trawlers												
Taiyo Gyogyo	*#3 Tenyo Maru*	2				19	8		17				
Nippon Suisan Kaisha	*Yamato Maru*	1				4	33						
Hoko	*Tsuda Maru*	1					18						
Kuykuyo	*Ohtori Maru*	2						21				23	
Hakodate Kokai	*#3 Zuiyo Maru*	1						17	17				
Nichiro	*72 Akebono Maru*	2						17	13			31	
Nippon Suisan Kaisha	*Rikuzen Maru*	1							30				
Hokuyo Suisan	*#3 Koyo Maru*	1								31			
Taiyo Gyogyo	*#5 Tenyo Maru*	1								22			
Hoko	*Chikubu Maru*	1									29		
Nippon Suisan Kaisha	*Haruna Maru*	2									20		16
Taiyo Kyogyo	*Tenyo Maru*	1										2	26
	Total	32				69	73	130	118	101	140	110	103

[1] Including Canadians through the International Pacific Halibut Commission.
[2] Pair trawlers.
[3] Danish seiners.
[4] Dependent stern trawlers.

length from 30 to 80 cm (Fig. 11). Based on age-length relationships determined by IPHC, the halibut were mainly 4 to 8 years old. They were younger than those caught by the U.S. and Canadian setline fishery whch are predominently 8- to 15-year-olds.

The total individual catch of halibut was estimated by multiplying the incidence observed in each area and month by the respective groundfish catch. The results show that the annual incidental catch increased to about 3 million fish (3,000 metric tons) in the early 1970's.

By agreement, halibut taken incidentally by Japanese trawlers east of long. 175°W are returned to the sea. As noted by observers, however, mortality of halibut, due to crushing in the net, extended exposure to air and cold, and predation by sea lions on return to the sea, has been high—from 60 to 100 percent.

Realizing the importance of the productive trawl fisheries and recognizing that foreign trawling will likely continue, even if national fishery zones are extended, IPHC proposed a scheme to reduce the incidental catch of halibut and also allow a productive trawl fishery. In 1973, IPHC proposed that foreign trawling be prohibited in particular areas in the Bering Sea when the incidence of halibut was high but trawl effort was low. Other areas would be open to trawling year-round and the closed areas would be open to fishing at times when the incidental catch of halibut was low, thereby allowing time and area in which to conduct a productive trawl fishery. The governments of Canada and the United States supported the IPHC proposal and, through negotiations, the Japanese agreed to most of the closures (IPHC, 1973). In response to a second proposal by IPHC in 1974, negotiations continued and Japan agreed to expand the duration and area of the Bering Sea closures for 1975. These closures will reduce the incidental catch of halibut by several thousand metric tons and should improve catches in the setline fishery.

Incidental Catch of Crab

King and snow crab have been harvested in the eastern Bering Sea for many years, although the catch has

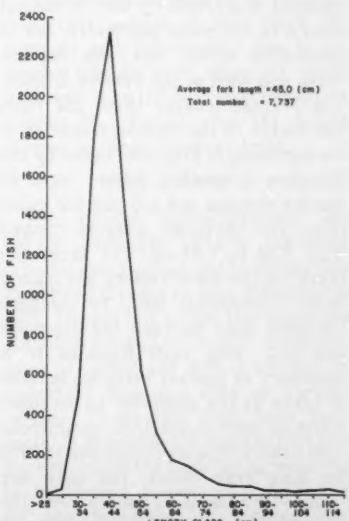


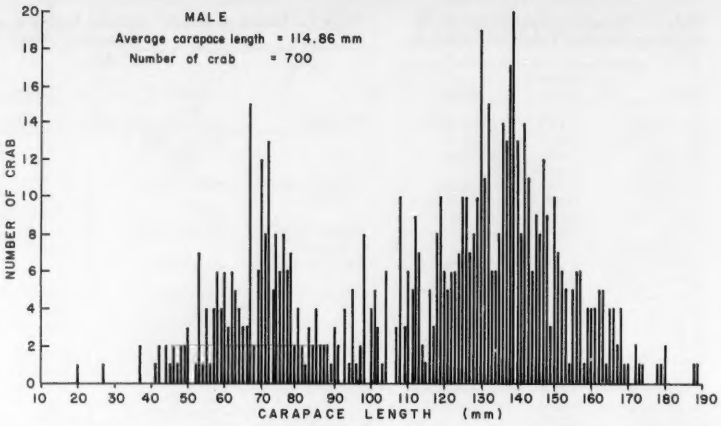
Figure 11.—Length frequency distribution of halibut in Japanese trawls March 1973-June 1974.

varied (Table 3). Japanese king crab landings have decreased in recent years because of quotas and gear restrictions (established through bilateral agreements) while U.S. catches have increased. United States landings of snow crab have not been large, but increased effort for these species is expected in the future.

Table 3.—Commercial crab catch (in thousands) in the eastern Bering Sea by country, 1952-72.

	King crab[1]		Snow crab	
Year	Japan[2]	U.S.	Japan[2]	U.S.
1952	—	355	—	—
1953	1,276	361	—	—
1954	1,061	328	—	—
1955	1,129	313	—	—
1956	1,079	294	—	—
1957	1,171	107	—	—
1958	1,130	1	—	—
1959	1,292	—[3]	—	—
1960	1,949	88	—	—
1961	3,029	62	—	—
1962	4,591	10	—	—
1963	5,476	101	—	—
1964	5,895	123	—	—
1965	4,216	223	1,030	—
1966	4,202	140	1,490	—
1967	3,764	547	8,610	—
1968	3,853	1,505	11,980	6
1969	2,073	1,749	7,590	353
1970	2,080	1,683	18,190	482
1971	886	2,405	15,739	61
1972	874	3,994	15,207	43

[1] Male crab of legal size.
[2] Japanese catch data are used through permission of the Japan Fisheries Agency.
[3] No fishing in 1959.



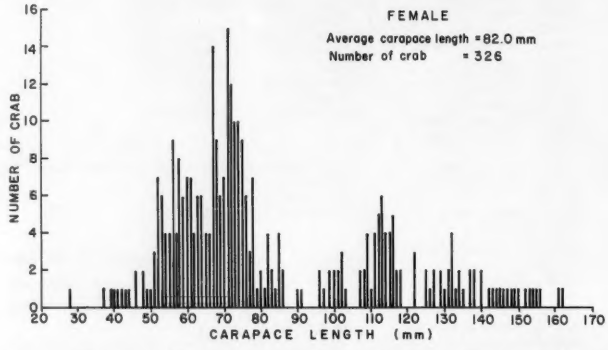


Figure 12.—King crab carapace length frequencies March 1973-June 1974.

According to observer data, the incidental king crab catch during trawling was relatively low. It ranged from 0 to 2.9 crabs per metric ton of groundfish catch, and was highest north and west of the Pribilof Islands. The average lengths (from the right eye socket to the median posterior of the carapace) of king crab taken by the Japanese groundfish fishery were 82 mm for females and 115 mm for males (Fig. 12). Average weights ranged from 1.24 to 1.54 kg. The king crab taken by the trawl fishery are mainly below commercial size. To compare carapace sizes between the Japanese and U.S. king crab fisheries it is necessary to convert carapace lengths as taken by the observers to carapace width as used in the U.S. commercial crab fishery. The minimum size in 1973 for king crab males, the only sex retained by the U.S. fishery, was 139 and 143 mm in carapace length (159 and 165 mm in carapace width), depending on the season.

Snow crab are much more abundant than king crab in the Japanese trawl catches. These were taken in all areas and seasons, but were most abundant west and north of the Pribilof Islands during fall and winter. Incidence of snow crab ranged from 0 to 180 per metric ton of catch. On the basis of observed snow crab incidence, the Japanese groundfish fishery in the eastern Bering Sea captured about 118 million snow crab during 1972 (Kessler, Somerton, and Schultz[4]). Average weights for incidentally taken snow crab were between 0.45 and 0.60 kg. The average carapace width of the crab was 58.7 mm for females and 91.6 for males (Fig. 13). Although there is no minimum size for snow crab, U.S. processors accept only the males larger than 125 mm in carapace width. Based on the length frequency distribution from observer samples (Fig. 13), a large proportion of snow crab taken by the Japanese trawl fishery was below the minimum U.S. commercial size of 125 mm.

Even though snow crab taken in the Japanese groundfish fishery are returned to the sea, their mortality is high. Observer data indicated that there is 50 percent mortality before the crab are returned to the sea. A similar mortality rate was reported by Hayes[5], who showed that crab survival decreases with increased time on deck, mixture with fish, and subjection to pressure of overlying catches. Simulated fish bin conditions showed a 50 percent mortality after only 6 hours.

[4] Kessler, D. W., D. A. Somerton, and R. D. Schultz. 1974. Incidence of Tanner crab in the groundfish catch of the Japanese eastern Bering Sea trawl fishery. Unpublished manuscript on file at the Northwest Fisheries Center, National Marine Fisheries Service, NOAA, Seattle, WA 98112.

[5] Hayes, Murray L. 1973. Survival of Tanner crabs (*Chionoecetes bairdi*) after capture in trawls and subsequent handling and storage aboard fishing boats. Unpublished manuscript on file at the Northwest Fisheries Center, National Marine Fisheries Service, NOAA, Seattle, WA 98112.

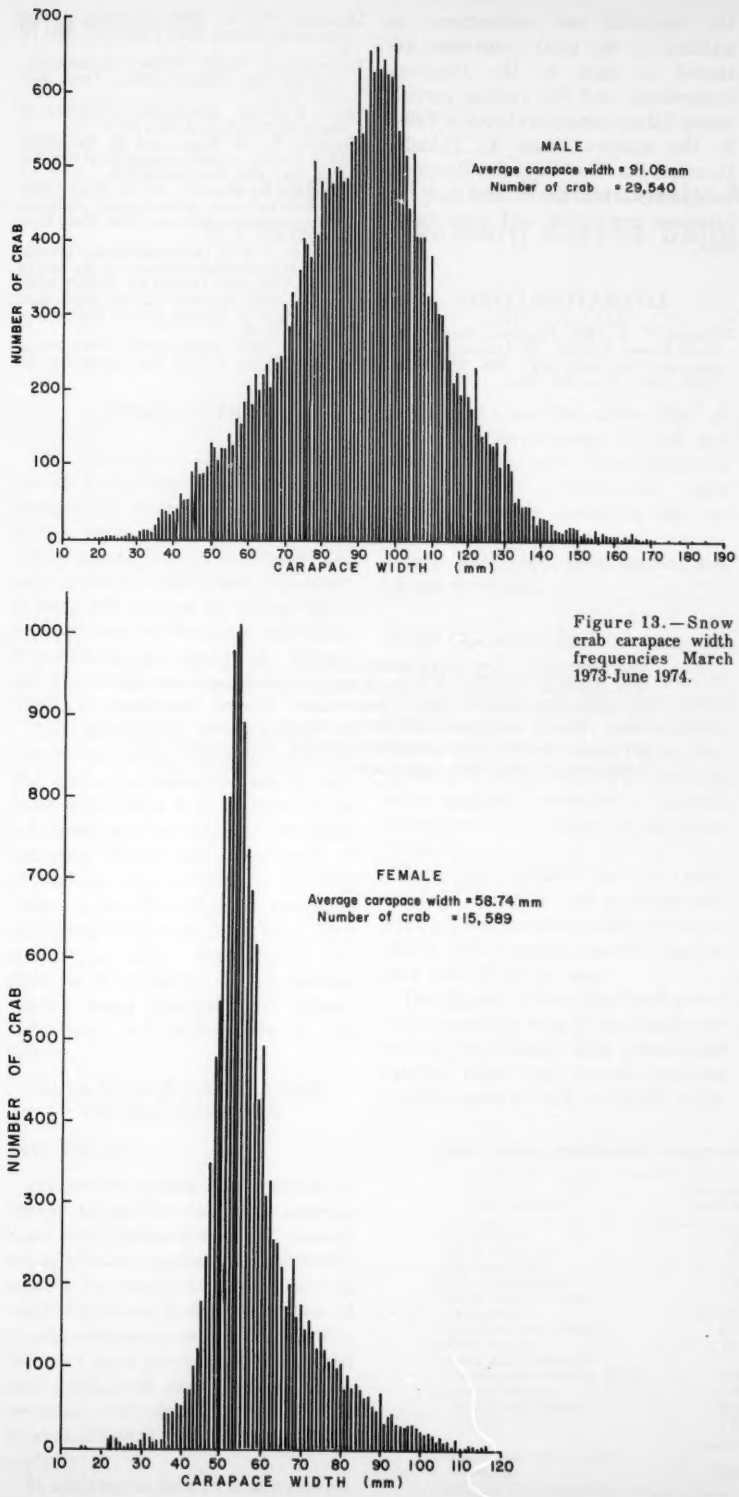


Figure 13.—Snow crab carapace width frequencies March 1973-June 1974.

Species Composition of Catch

Species composition data were combined from the individual observer trips to illustrate the general species composition in the Japanese trawl fishery during the observation period in 1973 and 1974 (Table 4).

Table 4.—Percentage composition by species from basket sampling aboard Japanese groundfish vessels, eastern Bering Sea, 1973-74.

Species	Number observed	Total wt. est. (mt)	% composition
Pacific halibut	1,220	280.483	0.137
Snow (Tanner) crab	25,585	4,808.398	2.353
King crab	372	58.410	0.029
Walleye pollock	642,935	167,585.170	81.999
Yellowfin sole	98,670	14,603.027	7.145
Pacific cod	11,507	7,243.990	3.545
Greenland turbot	21,560	2,687.796	1.315
Flathead sole	8,525	1,433.278	0.701
Rock sole	6,175	1,552.748	0.760
Rex sole	103	2.717	0.001
Alaska plaice	2,503	1,072.720	0.525
Arrowtooth flounder	2,221	950.744	0.465
Sablefish	3,221	111.951	0.055
Atka mackerel	1,006	71.415	0.035
Pacific ocean perch	2,791	323.108	0.158
Sculpin	3,000	1,091.161	0.534
Snailfish	1,736	113.434	0.056
Poacher	124	76.411	0.037
Herring	568	123.540	0.060
Misc. (Broken pieces of shell, starfish, sea urchins, snails, octopus, squid, and shrimp)	—	183.860	0.090
		204,374.361	100%

Walleye pollock were by far the most important species in the catch (81 percent) and represented the target species during most observer trips. Yellowfin sole, the next most important species (7 percent), was the target species on three observer trips.

OUTLOOK

The United States-Japanese observer program aboard Japanese groundfishing vessels in the Bering Sea completed 2 years of data collection in 1975. During this period the observers obtained estimates of the incidental catch of halibut and crab in addition to important biological data on various species. These data have been very useful in international negotiations and have provided the basis for agreements to implement conservation measures for the protection of commercially important species in the Bering Sea.

It is important for the United States

to continue the observer program because accurate and timely information on the effects of trawling on halibut and crab stocks is needed to evaluate remedial measures for conserving the resources. In addition, the acquisition of biological data will be increasingly important in order to study the impact of the large foreign fisheries on the various species of groundfish. In view of possible extended jurisdiction which would require the United States to manage these fisheries, knowledge of stock conditions will be essential. The information gained from the observer program, added to information obtained from our own research vessels, will provide the necessary data base and knowledge for effective conservation of the resource.

ACKNOWLEDGMENTS

The U.S. program of placing scientists and technicians aboard Japanese fishing vessels was accomplished through the cooperation of the Japanese Government and the Japanese fishing companies. The United States Government gratefully acknowledges the kind acceptance of the scientists and technicians, in addition to the many courtesies extended to them by the Japanese Government and the various participating fishing companies listed in Table 2. The authors thank Y. Fukuda, Director, Far Seas Fisheries Research Laboratory, for permitting use of Japanese groundfish and crab catch data.

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Profitability and Productivity Analysis for the Southeastern Alaska Salmon Fishery

DAVID S. LIAO

INTRODUCTION

The purpose of this paper is to provide knowledge of profitability and productivity of the various types of fishing vessels in the southeastern Alaska salmon fishery. Specifically, the paper provides information regarding: 1) costs and returns of fishing enterprises, 2) factors affecting profitability, 3) production functions of the fishery, and 4) average and marginal productivities of resources.

This information is important to commercial fishers and policy makers. The major management task of each commercial fisher is to organize his or her resources into the most profitable operating fishing unit. Knowledge of profitability and productivity can help fishers in the efficient use of resources to achieve their goals. In addition, for a commercial fishery management program to be effective, policy makers require some knowledge of fisher's operations and performance in the fishery.

DATA SOURCES AND VESSEL CHARACTERISTICS

Data Sources

Data were derived from a survey of fishers designed to determine average costs and characteristics of vessels engaged in the various Alaska fisheries in 1973. The sample for this survey was randomly drawn from a population of Alaska commercial salmon fishers. The skippers were personally interviewed and questioned about fishing costs, revenues, and vessel characteristics. A total of 122 samples were used in this analysis.

In addition to data from the survey, information from "fish ticket files" of the Alaska Department of Fish and Game were also used. These files are a computerized information data gathering system containing data on vessel number, species and amount caught, gear used, date landed, and management area.

Vessel Characteristics

Purse seine vessels are, on the average, larger and older than other fishing vessels in the southeastern Alaska area. The average purse seine vessel is 47 feet in keel length, and the main engine, normally a diesel, averages about 193 horsepower (Table 1).

Drift gill netters have a much smaller investment than purse seiners. Drift gill net vessels average 31 feet in length. The vessel is usually handled by a crew of one or two.

The skippers of hand troll and power troll vessels are alike in age. Hand troll vessels are smaller than power troll vessels. Hand troll vessels have an average market value of $5,567, while power troll vessels average $30,757. A second crew member is sometimes used in both types of trolling.

Surprisingly, hand trollers spend an average of only 5 weeks fishing in the southeastern salmon fishery and 2 weeks in the halibut fishery. Thus, they spend an average of 7 weeks fishing. This is in contrast to purse seiners, drift gill netters, and power trollers who spend 18 weeks fishing. Weeks fished in the southeastern salmon fishery are 9 and 12 for power trollers and drift gill netters, respectively.

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Table 1.—Mean characteristics of southeastern Alaska fishing vessels by gear type, 1973.

Characteristic	Southeastern purse seine	Southeastern drift gill net	Southeastern hand troll	Southeastern power troll
Sample size	19	45	37	21
Age of vessel (yr)	37	16	14	25
Keel length (ft)	47	31	22	35
Engine horsepower	193	160	108	110
Market value of vessel and gear ($)	67,132	22,573	5,567	30,757
Number of crew on vessel	6.5	1.4	1.3	1.7
Age of skipper	50	48	43	45
Weeks spent fishing in				
Southeastern salmon fishery	6.9	12.2	4.9	9.1
Halibut fishery	1.0	1.0	2.0	3.0
Out of state fishery	9.0	2.0	0.0	1.0
Others	1.2	2.7	0.0	5.1
Total weeks fished in all fisheries	18.1	17.9	6.9	18.2

PROFITABILITY ANALYSIS

Costs and Returns in Commercial Fishery

Gross returns is money received from salmon landed in the southeastern Alaska management area during the survey year. The estimated gross returns from purse seining was considerably higher than fishing income from other types of salmon fishing (Table 2). The gross returns of hand troll vessels was only $939, which was lower than their past 5-year average gross returns of $1,290.

Production costs are categorized as either variable or fixed costs. The variable costs comprise all cost items that are incurred only if the vessel is actually used for fishing. The fixed costs contain cost items that do not vary with fishing days. The variable costs of purse seine vessels were $14,813 but were only $822 for hand trollers. The fixed costs were $2,932 and $460 for purse seiners and hand trollers, respectively. Total production costs for purse seine vessels were $17,745 which were 14 times higher than production costs of hand trollers and four times higher than power trollers.

Gross returns less total costs is the amount left to cover interest payments, to provide personal needs, and to improve the fishing business. Gross returns less total costs were: –$342 for hand troll vessels, $24,500 for purse seine vessels, $11,063 for the drift gill net vessels, and $3,630 for power troll vessels. This indicated that only hand trollers, on the average, experienced an economic loss.

Although the average gross returns less total costs were positive for purse seine, drift gill net, and power troll vessels, not every vessel had made profits. Four percent of drift gill net vessels and 11 percent of purse seine vessels had total costs greater than gross returns. In contrast 68 percent of hand troll vessels and 24 percent of power troll vessels encountered total costs greater than gross returns. Thus, both types of trolling had not only lower profits but also a higher probability for operating at a loss.

Table 2.—Costs and returns based on fishing in southeastern salmon fishery by gear type, 1973.

Financial indicators	Southeastern purse seine	Southeastern drift gill net	Southeastern hand troll	Southeastern power troll
Investment[1]	$28.496.1	$15,627.9	$4,964.2	$18,112.8
Cost and returns				
Gross returns	$42,244.8	$16,254.1	$939.4	$7,949.8
Variable costs[2]	14,812.8	3,747.2	821.8	2,886.5
Fixed costs[3]	2,932.2	1,444.3	459.5	1,433.4
Gross returns less total costs	24,499.8	11,062.6	-341.6	3,629.9
Returns to labor and management[4]	21,935.2	9,656.0	-788.7	1,999.7
Returns to investment[5]	7,601.9	4,560.9	-717.7	449.9
Percent of vessels with gross returns less than total costs	11	4	68	24

[1]The market value of the vessel was prorated to the fishery, based on the amount of time fished.
[2]Costs that vary with fishing effort (may include fuel, boat repair, gear repair, crew's share, etc.).
[3]Costs that do not vary with fishing effort (may include insurance, license fees, association assessments, etc.).
[4]Gross returns less total costs less opportunity cost of investment, i.e., 9 percent of investment.
[5]Gross returns less total costs less opportunity cost of skipper's labor and management, i.e., 40 percent of gross return.

Factors Affecting Profitability

An attempt has been made to identify some factors that might be associated with profitability of vessels fished in the southeastern Alaska salmon fishery. Age of the vessel was chosen because most people would consider older vessels less productive, ceteris paribus, than new vessels. Vessel size could influence profit because it costs more to run a large vessel than a small vessel. Keel length and engine horsepower were the proxy for vessel size. Weeks fished and number of crew members on the vessel are indicators of fishing effort, and variable costs are a measure of overall size of the business. Fishing experience has been hypothesized as a determinant of profit. Unfortunately, age of skipper was the only factor available that could be used as a proxy for experience. It was also hypothesized that profits and gross returns are highly correlated. The correlation analysis was used and results are presented in Table 3.

The correlation between the profit and age of the purse seine vessels was negative and statistically significant. This indicated that the older the vessel, the less profit that may be realized from it. Variables with positive and statistically significant coefficients observed for this fishery were engine horsepower, weeks fished, and gross returns. These variables had a positive impact on profit of purse seine fishing.

For the drift gill net vessels, weeks fished and gross returns were the variables affecting profits, while gross returns were the only variables which had positive effects on the profit of power troll vessels.

For the hand troll vessels, negative and significant coefficients for engine horsepower and variable costs were observed. This indicated that capital investment in hand troller equipment did not bring profits to the vessel owners. Gross returns had a positive impact on profits of hand troll vessels.

PRODUCTIVITY ANALYSIS

This section deals with the estimation of production functions and resource productivities. The production function is a technological

Table 3.—Correlation coefficients of profits and business factors of fishing in southeastern salmon fishery by gear type, 1973.

Factors	Southeastern purse seine	Southeastern drift gill net	Southeastern hand troll	Southeastern power troll
Age of vessel (yr)	-0.62**	-0.19	0.06	-0.09
Keel length (ft)	0.29	-0.12	-0.20	0.22
Engine horsepower	0.80**	0.10	-0.44**	0.24
No. of crew on vessel	0.15	0.20	-0.04	-0.31
Weeks fished	0.70**	0.69**	0.27	0.23
Gross returns	0.92**	0.92**	0.64**	0.92**
Variable costs	0.34	0.29	-0.54**	0.08
Age of skipper	0.10	-0.12	-0.30	-0.05

**Significant at 1 percent probability level.

Table 4.—Production functions of southeastern salmon fishery by gear type, 1973.

Equation	Gear type			Vessel capital X_1	No. of crew X_2	Weeks fished X_3	Operating capital X_4	
(1)	Southeastern purse seine	$Y =$	3.166 (4.258)***	- 0.002X_1 (-0.012)	- 0.051X_2 (-0.019)	+ 1.381X_3 (5.180)***	+ 0.067X_4 (0.480)	$R^2 = 0.81$ D-W = 1.94 $N = 19$
(2)	Southeastern drift gill net	$Y =$	2.412 (6.607)***	+ 0.127X_1 (1.235)	+ 0.362X_2 (1.943)*	+ 1.134X_3 (8.418)***	- 0.010X_4 (-0.112)	$R^2 = 0.84$ D-W = 2.21 $N = 45$
(3)	Southeastern hand troll	$Y =$	1.228 (2.587)**	- 0.233X_1 (-1.347)	- 0.337X_2 (-0.593)	+ 1.436X_3 (4.867)***	+ 0.483X_4 (2.683)**	$R^2 = 0.64$ D-W = 2.23 $N = 37$
(4)	Southeastern power troll	$Y =$	-0.606 (-0.588)	+ 0.441X_1 (1.893)*	- 0.422X_2 (-0.959)	+ 0.882X_3 (1.754)*	+ 0.525X_4 (1.599)	$R^2 = 0.84$ D-W = 1.52 $N = 21$

Where $Y = \log Y_i$, $X_j = \log X_j$.
Figures in the parentheses are t- statistics.
*** Significant at 1 percent probability level.
** Significant at 5 percent probability level.
* Significant at 10 percent probability level.
D-W = Durbin-Watson statistic.
N = sample size.

relationship between output and a set of factor inputs. Marginal productivities of resources are derived from the production functions.

Production Functions

The following form of production function was employed:

$$\log Y = \log a + b_1 \log X_1 + b_2 \log X_2 + b_3 \log X_3 + b_4 \log X_4$$

where: Y = gross returns in dollars,
X_1 = vessel capital in dollars (i.e. vessel + gear values prorated to the salmon fishery based on weeks fished),
X_2 = number of crew members on the vessel,
X_3 = weeks fished in the fishery, and
X_4 = operating capital in dollars (i.e. variable costs less crew shares).

The first equation in Table 4 is the production function for the purse seine vessels. The elasticities of production (regression coefficients) indicate the percentage in gross returns that would be forthcoming with one percentage increase in the indicated resource. For example, weeks fished had a statistically significant coefficient of 1.381. This indicated that an increase in weeks fished by one percent would bring about an increase in gross returns by 1.381 percent, holding other input constant. The estimate of the coefficient of multiple determination (R^2) in the equation was 0.81. Thus, about 81 percent of the variation in gross returns was explained by the variables in the equation.

In all equations estimated, weeks fished were statistically significant. Overall, weeks fished appeared to be quite important, as fishers would expect. Fishers frequently say that "if you're not out fishing, you'll not catch fish." Vessel capital was significant in only power troll vessel equations. Similarly, operating capital was significant for hand troll vessels and number of crew members on the vessel for drift gill net vessels.

Resource Productivities

The marginal productivity of a resource is simply the addition to gross returns associated with the addition of one unit of a given resource. The marginal productivity of operating capital was $0.24 for hand troll vessels (Table 5). In other words, the spending of one more dollar beyond the mean quantity per vessel in the hand troll sample, would add only 24 cents to gross returns. This implies that hand

Table 5.—Mean quantities of production, resources, and productivity of specified resources based on southeastern salmon fishery by gear type, 1973.

Item	Southeastern purse seine	Southeastern drift gill net	Southeastern hand troll	Southeastern power troll
Mean value of production per vessel (Y)	$42,244.8	$16,254.1	$939.4	$7,949.8
Mean resources per vessel				
Vessel capital (X_1)	28,496.0	15,627.8	4,984.1	18,112.8
No. of crew (X_2)	6.5	1.4	1.3	1.7
Weeks fished (X_3)	6.9	12.2	4.9	9.1
Operating capital (X_4)	10,432.7	2,970.6	767.2	2,432.3
Average product at resource means				
Vessel capital (X_1)	1.48	1.04	0.18	0.44
No. of crew (X_2)	6,499.2	11,610.1	722.6	4,676.4
Weeks fished (X_3)	6,122.4	1,332.3	191.7	873.6
Operating capital (X_4)	4.05	5.47	1.22	3.27
Marginal product at resource means				
Vessel capital (X_1)	-0.01	0.09	0.02	0.15*
No. of crew (X_2)	-86.1	2,973.6*	-99.3	-1,559.1
Weeks fished (X_3)	7,465.4***	1,068.9***	112.2***	606.8*
Operating capital (X_4)	0.24	-0.04	0.24**	1.40

*** Significant at 1 percent probability level.
** Significant at 5 percent probability level.
* Significant at 10 percent probability level.

troll vessels should not increase their operating capital. Similarly, the same can be said for the vessel capital of power troll vessels. The significant marginal productivity of number of crew members for drift gill net vessels showed the potential value in using more crew in drift gill netting.

Marginal productivity of weeks fished was $7,465 for purse seine, $1,069 for drift gill net, $609 for power troll, and $112 for hand troll vessels. The substantially greater marginal productivity of weeks fished for purse seine vessels was probably due to the higher factors ratio of operating capital/weeks fished and number of worker/weeks fished. Weeks fished could be increased to yield greater gross returns to fishers. However, this opportunity may not always exist because of the high variation in commercial salmon runs and regulation of the fishing season.

The average productivity of resources is measured by gross returns/resource used. Hand troll vessels produced much lower average productivities of all resources than others.

SUMMARY AND CONCLUSIONS

Purse seine vessels had gross returns of $42,245, total costs of $17,745, and gross returns less total costs of $24,500. The average gross returns of the drift gill net vessels were $16,254, while their average costs were $5,191. Similarly, the power troll vessels received gross returns of $7,969 and spent $4,319 for production costs. In contrast to these vessels, hand troll vessels experienced low gross returns of $939 and encountered an economic loss in 1973. There were 68 percent of hand troll vessels with total costs greater than gross returns. This was due to the fact that 1973 was a poor year for the hand troll salmon fishery.

The correlation analysis was employed to determine correlation between profitability and socio-economic factors. The gross returns had the highest level of correlation with profits among the variables studied. This implied that gross returns is the most important factor related to profit.

To determine factors affecting gross returns, the production functions for each fishery were estimated. The results indicated that weeks fished was the most important variable for all gear types. Therefore, week fished could be increased to yield greater returns to fishers in the salmon fishery.

The extent for spending additional weeks in salmon fishery to raise gross returns depends on the marginal productivity of weeks fished. The marginal productivity of weeks fished was about $7,464 for the purse seine vessels, about $1,069 for the drift gill net vessels, about $609 for the power troll vessels, and $112 for hand troll vessels.

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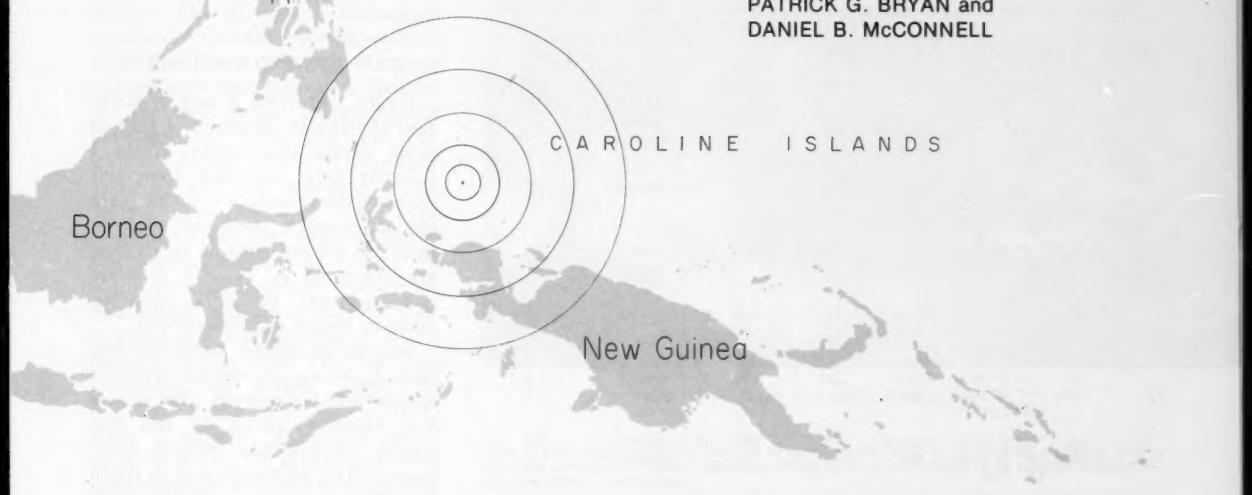
MFR PAPER 1183

Helen Reef's large tridacnid clams have declined sharply in recent years.

Status of Giant Clam Stocks (Tridacnidae) on Helen Reef, Palau, Western Caroline Islands, April 1975

PATRICK G. BRYAN and
DANIEL B. McCONNELL



Abstract—A total of 24,800 m² were covered in transects made on Helen Reef to assess population levels of Tridacnidae. Standing stock estimates were: Tridacna gigas, *8.6 x 10³;* T. derasa, *12.9 x 10³;* T. maxima, *1.4 x 10⁶; and* Hippopus hippopus, *47.4 x 10³.* Tridacna crocea *was omnipresent.* Tridacna squamosa *was difficult to identify and only three were seen. A similar study conducted in 1972 gave the following estimates:* Tridacna gigas, *49.8 x 10³;* T. derasa, *32.8 x 10³;* T. maxima, *1.7 x 10⁶ and* H. hippopus, *44.6 x 10³. A large percentage of three species were dead z* (empty *shells):* Tridacna gigas—*4 live, 206 dead;* T. derasa—*6 live, 168 dead; and* H. hippopus—*22 live, 458 dead. The reduction in population numbers of these three species is attributed to human exploitation.* Tridacna maxima *and* T. crocea *did not appear to have been exploited.*

INTRODUCTION

Helen Reef is a small atoll lying on the southernmost border of Palau District, Trust Territory of the Pacific Islands, at approximately lat. 3°N and long. 131°E. The barrier reef and lagoon reefs (patch reefs) harbored, until recently, considerable populations of tridacnid clams (giant clams), of which several species are highly valued for their meats and shells. The family Tridacnidae includes six species, all of which are limited in distribution to the Indo-Pacific faunal region (Rosewater, 1965). They are: *Tridacna gigas* (Linné), *T. derasa* (Röding), *T. squamosa* Lamarck, *T. maxima* (Röding), *T. crocea* Lamarck, and *Hippopus hippopus* (Linné).

In March 1972 a group of biologists from the Honolulu Laboratory of the National Marine Fisheries Service were called upon by the Division of Marine Resources, Trust Territory of the Pacific Islands, to conduct a survey of Helen Reef and assess standing stocks of tridacnid clams. They concluded that population levels of tridacnids were high at the time of their survey (Hester and Jones, 1974). Since that time, foreign fishing vessels poaching on Helen Reef have been captured by the Trust Territory field trip vessel with alarming frequency. For this reason, the Palau Marine Resources Office chartered the Oceanic Society's flagship *New World* in April 1975 to carry a team of biologists to Helen Reef so that a resurvey could be made. The purpose of this survey was to assess population levels of important marine organisms which are being exploited by foreign fishing vessels and to some extent by the unauthorized

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Trust Territory flagship. Particular emphasis was placed on assessing tridacnid clam stocks.

METHODS

Straight line transects, 2 m in width, were used almost exclusively in this survey. Transects on the barrier reef were made by swimming with an inflatable boat from the lagoon slope normal to the reef as far into the surf zone as circumstances allowed. In some cases, because of currents, the transects began in the surf zone and ran to the lagoon slope. Tridacnid clams lying within the transect path of 2 m were counted and recorded on underwater writing boards. Patch reefs within the lagoon were transected from the lagoon slope on one side to the lagoon slope on the adjacent side. All transects ran true north, east, south, or west. The only deviation from the transect methods were two areal tows which were made along the lagoon terrace and which followed the contour of the lagoon slope. Counts, however, were limited in these tows to a 2-m path as in the transects. Strong winds and high seas prevented survey of the outer reef front and terrace. Positions and measurements were figured from the Navy Hydrographic Office chart of Helen Reef, No. 6072, 1st edition, April 1944.

Table 1.—Survey data of live tridacnid clams taken from transects and areal tows on Helen Reef. T = transect. A = areal tow. *Tridacna crocea* not included.

Station	Location and direction of transect or areal tow	Reef type	Length of transect or areal tow (m)	Area surveyed (m^2)	No. of live species counted	Clam density per 100 m^2
T_1	lat. 2° 51′ 10″N long. 131° 44′ 16″E 270° true	Barrier reef	650	1300	5-*T. maxima* 1-*H. hippopus*	0.4 0.1
T_2	lat. 2° 48′ 46″N long. 131° 45′ 06″E 180° true	Barrier reef	650	1300	3-*T. maxima*	0.2
T_3	lat. 2° 51′ 24″N long. 131° 48′ 23″E 90° true	Barrier reef	975	1950	60-*T. maxima* 1-*H. hippopus* 1-*T. squamosa*	3.1 0.1 0.1
T_4	lat. 2° 50′ 33″N long. 131° 45′ 48″E 270° true	Patch reef	475	950	27-*T. maxima*	2.8
T_5	lat. 2° 50′ 24″N long. 131° 45′ 30″E 180° true	Patch reef	325	650	51-*T. maxima* 1-*T. gigas*	7.9 0.2
T_6	lat. 2° 52′ 13″N long. 131° 45′ 03″E 180° true	Channel reef	475	950	49-*T. maxima* 1-*T. derasa*	5.2 0.1
T_7	lat. 2° 53′ 13″N long. 131° 44′ 56″E 270° true	Patch reef	325	650	53-*T. maxima* 1-*T. gigas* 1-*T. derasa*	8.2 0.2 0.2
T_8	lat. 2° 54′ 42″N long. 131° 45′ 14″E 270° true	Barrier reef	975	1950	61-*T. maxima* 1-*T. derasa* 2-*H. hippopus*	3.1 0.1 0.1
T_9	lat. 2° 56′ 20″N long. 131° 46′ 53″E 270° true	Barrier reef	975	1950	39-*T. maxima* 2-*T. derasa* 1-*T. squamosa*	2.0 0.1 0.1
T_{10}	lat. 2° 58′ 00″N long. 131° 48′ 16″E 270° true	Barrier reef	1125	2250	44-*T. maxima*	2.0
T_{11}	lat. 2° 59′ 05″N long. 131° 48′ 30″E 270° true	Barrier reef	800	1600	43-*T. maxima* 3-*H. hippopus*	2.7 0.2
T_{12}	lat. 3° 00′ 30″N long. 131° 48′ 55″E 0° true	Barrier reef	650	1300	2-*T. maxima*	0.2
T_{13}	lat. 2° 58′ 06″N long. 131° 49′ 24″E 90° true	Barrier reef	1600	3200	137-*T. maxima* 1-*T. derasa* 9-*H. hippopus*	4.3 0.03 0.3
T_{14}	lat. 2° 56′ 30″N long. 131° 49′ 51″E 90° true	Barrier reef	1125	2250	4-*T. maxima* 6-*H. hippopus*	0.2 0.3
T_{15}	lat. 2° 58′ 00″N long. 131° 49′ 00″E 180° true	Patch reef	325	650	37-*T. maxima*	5.7
A_1	lat. 2° 49′ 00″N long. 131° 44′ 30″E Direction variable	Lagoon terrace	475	950	2-*T. maxima*	0.2
A_2	lat. 2° 50′ 30″N long. 131° 47′ 30″E Direction variable	Lagoon terrace	475	950	12-*T. maxima* 2-*T. gigas*	1.3 0.2

RESULTS AND DISCUSSION

Figure 1 presents a map of Helen Reef showing the localities of stations made during this survey. Table 1 presents data calculated from live tridacnid clam counts according to each station. Standing stock estimates for tridacnid species found on Helen Reef are presented in Table 2 and are compared with the 1972 estimates made by Hester and Jones (1974).

Because of limited manpower and time, *T. crocea* (the smallest tridacnid species) was not counted. This species was extremely abundant and was usually omnipresent. *Tridacna squamosa* is either extremely rare on Helen Reef (Hester and Jones, 1974) or is so morphologically similar to *T. maxima* as to be almost indistinguishable. Only

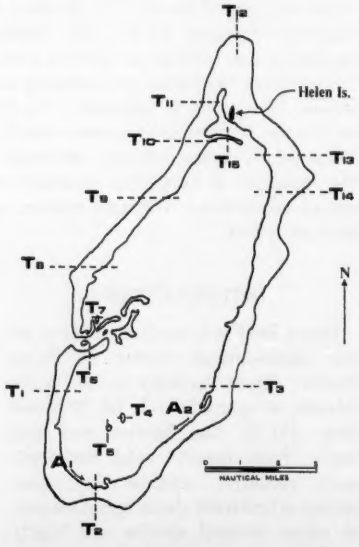

Figure 1.—Localities of survey stations made on Helen Reef. T = transect. A = areal tow.

three *T. squamosa* were identified (2 live, 1 dead) during this survey, and the authors are not absolutely positive of their proper identification. Hardy and Hardy (1969) apparently found no difficulty distinguishing between *T. squamosa* and *T. maxima* in Palau proper.

The results of this survey show that Helen Reef has been systematically harvested of at least two species of tridacnid clams, *T. gigas* and *T. derasa*. The graveyard appearance (empty shells) on the reef suggests that only the fleshy portions of these species have been harvested. Most of the captured foreign fishing vessels have had their holds filled only with tridacnid muscles. Many of the empty shells on the reef appeared to be several years old, i.e., they were encrusted with algae, sponges, corals, and other invertebrates. About 50 shells were unidentifiable because of weathering and deterioration. This suggests that the exploitation of tridacnid clams on Helen Reef has been proceeding for several years. By contrast, Hester and Jones (1974) made no mention of sighting empty shells in their 1972 survey and even suggested that a moderate fishery for *T. gigas* and *T. derasa* might be initiated with caution. It must be assumed from their report that the clam population on Helen Reef had not been exploited to a noticeable extent at the time of their survey (March 1972) and that methodical harvesting probably began sometime after March 1972.

In January 1937, Motoda (1938) visually estimated the number of *T. gigas* around his ship's anchorage to be 5 to 6 per 13 m^2. He also reported seeing many empty *T. gigas* shells, which he attributed to harvesting by Nanyo-Boeki Co. several years earlier. A comparitive estimate of *T. gigas* from the 1972 survey of Hester and Jones (1974), derived from the station which gave the highest count (23 counted in 1,600 m^2), would be 0.187

Patrick G. Bryan with empty *T. gigas* shell.

Table 2—Summation of survey data for tridacnid clams found on Helen Reef. Standing stock estimates are based on Hester and Jones' (1974) figure of 5,340 hectares as suitable habitat for tridacnid clams on Helen Reef.

Species	Live	Dead	Percent live	Percent dead	1975 Estimate of standing stock	1972 Estimate of standing stock[1]
T. gigas	4	206	1.9	98.1	8.6×10^3	49.8×10^3
T. derasa	6	168	3.4	96.6	12.9×10^3	32.8×10^3
T. maxima	629	23	96.5	3.5	1.4×10^6	1.7×10^6
T. crocea	Omni-present	—	—	—	—	3.7×10^6
T. squamosa	2	1	66.7	33.3	4.3×10^3	—
H. hippopus	22	458	4.6	95.4	47.4×10^3	44.6×10^3

[1] Data from Hester and Jones (1974).

Empty *T. gigas* containing swim fin for size comparison.

Survey party aboard *New World* at Helen Reef. Trust Territory field trip ship in background.

per 13 m^2. This survey's highest estimate of *T. gigas*, derived from station A_2 (2 counted in 950 m^2) is 0.027 per 13 m^2. These figures imply that *T. gigas* has declined rapidly since 1937, but further systematic harvesting after 1972 resulted in obvious overexploitation.

Standing stock estimates made by Hester and Jones (1974) for *T. gigas* (49.8×10^3) and *T. derasa* (32.8×10^3) contrast sharply with our figures of 8.6×10^3 and 12.9×10^3, respectively. We counted only four live *T. gigas* (206 dead, 98.1 percent) and six live *T. derasa* (168 dead, 96.6 percent). Our standing stock estimate for *H. hippopus* (47.4×10^3) is similar to the estimate of 44.6×10^3 made by Hester and Jones (1974). However, we counted only 22 live *H. hioppopus* versus 458 dead (95.4 percent). This survey indicated that *T. gigas*, *T. derasa*, and *H. hippopus* have been harvested at depths up to around 20 m, about the maximum depth tridacnids are found (Hardy and Hardy, 1969), and suggests that sophisticated diving gear, such as scuba (self contained underwater breathing apparatus) or hooka (surface supplied air), may have been used to harvest the deeper clams. The current authors consider any further fishing for tridacnid clams on Helen Reef to be unfeasible in terms of catch per unit effort. Live *T. gigas*, *T. derasa*, and *H. hippopus* are presently scarce and probably only those which were overlooked by fishing parties remain. *Tridacna crocea* and T. *maxima* apparently have not been exploited. Either these have no commercial value or it has been unfeasible to harvest them because of their relatively small size.

Motoda (1938) reported not finding any *T. gigas* smaller than 30 cm in valve length on Helen Reef. Hester and Jones (1974) reported similar observations. They found only two *T. gigas* smaller than 30 cm, the smallest being 20 cm, and concluded that recruitment may be erratic or low. In this survey, although actual measurements were not taken, the authors believe the smallest *T. gigas* seen, live or dead, was at least 20 cm in valve length and most were larger than 30 cm.

Life-span of tridacnids is said to range from eight to several hundred years (Hardy and Hardy, 1969) and several short term growth rate experiments have suggested that *T. gigas* may grow about 5 cm in valve length per year (Bonham, 1965; Rosewater, 1965). However, McMichael (1974) showed that in *T. maxima* growth is a function of size. His data indicated that growth is relatively rapid during the early years of life, slowing down with increasing size. If *T. gigas* has similar growth, about 20 years may be required for this species to reach a valve length of 1 m.

Tridacna gigas, *T. derasa*, and *H. Hippopus* populations have declined drastically, apparently through human exploitation, on Helen Reef in recent years. *Tridacna gigas* is probably the most sought after because its large size and abundance makes it easy to see and efficient to harvest. Assuming that recruitment is erratic or low and that growth is slow, many years may be required for *T. gigas* to substantially repopulate if no further human predation occurs. Continued harvesting may severely retard or endanger the survival of *T. gigas* on Helen Reef.

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MFR PAPER 1184

Escape of Dungeness Crabs from Pots

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ABSTRACT—Dungeness crab, Cancer magister, *unable to escape from derelict pots (traps whose buoylines have parted) could be confined until death and lost to the fishery. Therefore, the National Marine Fisheries Service, in cooperation with the Washington Department of Fisheries and the Fish Commission of Oregon, conducted four experiments to determine whether Dungeness crabs could escape from standard ocean- and bay-style pots. Divers placed marked crabs into pots set without surface buoys on a sand bottom in Puget Sound, Wash. Female crabs and sublegal (carapace less than 6¼ inches across) and legal size male crabs escaped quickly from pots having escape rings open and triggers raised (inoperative). Pots with functional (operative) triggers and open escape rings allowed less escapement, especially for larger crabs. Crabs confined in pots having escape rings closed and with functional triggers were observed at intervals for 74 days, at which time 21 percent of the large and 67 percent of the small crabs had escaped. Of those crabs remaining alive, nearly all escaped within 3 days after the triggers were raised. Study results indicate that 1) escapement is directly related to availability of openings large enough to pass a crab and that 2) triggers are an effective means for reducing escapement.*

INTRODUCTION

Numerous pots (i.e., traps) that are used in Dungeness crab, *Cancer magister*, fisheries are lost each year in coastal waters from Alaska southward to central California. Because they may continue to catch crabs for long periods it is desirable to know whether confined crabs can escape. Also, pots set in exposed shallow waters are often buried in sand during storms and unless crabs promptly escape from these pots, they will be killed during the sanding-in process[1].

As part of an effort to estimate the potential loss of crabs in derelict pots (pots whose longlines have parted) and sanded-in pots, the National Marine Fisheries Service, in cooperation with the Washington State Department of Fisheries and the Fish Commission of Oregon[2], conducted four experiments from October 1974 to January 1975. Our aim was to learn whether Dungeness crabs could escape from commercial-style crab pots. Specifically, we wanted to learn how rapidly crabs could exit pots having 1) tunnel triggers functional and escape rings open (normal fishing configuration), 2) triggers functional and escape rings sealed, and 3) no tunnel triggers and escape rings open.

METHODS AND MATERIALS

Before discussing the specific experiments in detail, a general description of the methods, experimental pots, and handling of test crabs is presented.

Scuba diving investigators carried crabs into unbaited pots already placed on the sea floor and made periodic observations in situ (Fig. 1). Without

[1]Tegelberg, Herb C. 1974. Coastal Dungeness crab study. Wash. Dep. Fish., Olympia, Proj. Prog. Rep., Proj. 1-92-R, Contract 04-4-208-55 with U.S. Dep. Commer., Natl. Oceanic Atmos. Admin., Natl. Mar. Fish. Serv., Aug. 5, 1974, 27 p. Processed report.

[2]The Fish Commission of Oregon and the Oregon Wildlife Commission have since been merged as the Oregon Department of Fish and Wildlife.

Figure 1.—Marked crabs were carried by divers to the pots already set on the sea floor.

bait, the pots simulated a condition common among crab pots which are lost.

Description of Gear

The two crab pot styles used in these experiments, ocean and bay pots, were borrowed from commercial fishers and numbered for identification. The ocean pots were 40 inches in diameter, 12½ inches deep, and weighed 73 pounds (Fig. 2). The stainless steel wire meshes had maximum openings of 3⅝ × 3¼ inches. One circular escape port (ring), 4⅛ inches inside diameter, was located on the side of each pot for egress of undersized crabs (Hipkins, 1972). The oval tunnel orifices were 8¼ × 3⅞ inches and had two vertical triggers working in unison (Fisher, 1970).

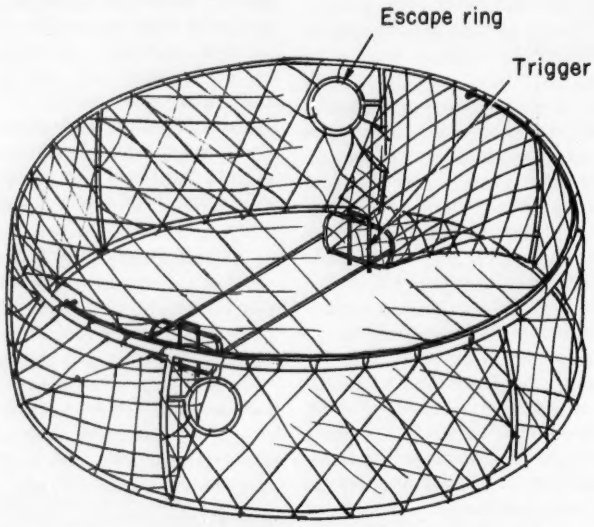

Figure 2.—A typical Dungeness pot showing the triggered tunnel opening and crab escape rings.

Bay pots are essentially a smaller version of the ocean pot. Each weighed 50 pounds with dimensions of 33 inches across and 10½ inches deep. Maximum mesh size was 4 × 3½ inches. Escape rings were 4¼ inches inside diameter. Tunnel orifices were slightly larger than on ocean pots, 8⅜ × 4⅝ inches. Each orifice has two vertical triggers working independently of each other.

Construction differences between the ocean and bay pots which might contribute to a differential crab escapement included sizes of pots, tunnel orifices, escape rings, and mesh openings; the working arrangement of the two triggers were unison versus independent.

Source of Crabs

Crabs used in the experiment were obtained from two sources. Initially, they were purchased from a commercial fisher operating a string of pots in Puget Sound off Everett, Wash. The crabs were held on the fishing vessel's deck in a cool, moist box for about 1½ hours, until all pots were lifted. They were then transferred to tubs filled with seawater and transported to the site of the experiment, which was located off Seattle about 20 miles from Everett. Water in the tubs was changed several times. From time of capture, the crabs were held for less than 3 hours before introduction into test pots.

Other experimental crabs were collected in Willapa Bay on the western coast of Washington by scientists of the Washington Department of Fisheries. The crabs were confined in mesh bags and held in the bay overnight. The following morning, the crabs were transported about 130 miles to Seattle and Puget Sound in an open truck. Only three of these crabs were rejected because of poor condition.

Marking Test Crabs

Marks were placed on each carapace so investigators could readily identify the three study groups—female crabs and sublegal size male (less than 6¼ inches across the carapace measured ahead of the extreme points) and legal size male crabs—without handling during the experiment. Orange plastic "disc" tags were imbedded into a small amount of an epoxy-based putty normally used for marine repairs under wet or dry conditions, and placed on the left, middle, or right side of the carapace. In some experiments, the putty was strategically applied without tag discs. Before applying the putty, the carapace was rubbed with a rag to remove excess moisture and organic matter that might hinder it from adhering to the shell.

Study Site

The experiment was conducted in Puget Sound near Seattle and NMFS's Northwest Fisheries Center to facilitate observations. Buoys were not used to mark the location of the pots to prevent recreational boaters and commercial fishers from disturbing the gear. Buoys were not needed, however, because accurate soundings of water depth and bearings of landmarks permitted ready return to the pots.

EXPERIMENTAL PLAN AND RESULTS

Four experiments were conducted to identify the escape rate and possible exit points for Dungeness crabs. Procedure and results for each experiment are reported together as a convenience to the reader. The numbers of pots and crabs used in each experiment are shown in Table 1. When determining escapement, all crabs that died in the pots were considered to have remained in the pot during the experiment. Consequently 100 percent escapement was not possible when mortalities occurred.

Experiment A: Ocean Pots with Tunnels and Escape Rings Open

This experiment commenced 10 October 1974 to determine crab escapement from ocean pots having the triggers tied up (inoperative) and escape rings open.

Table 1.—Number of crabs by sex and size in each experiment.

Experiment	Number of pots used	Pot features	Number of crabs		
			Female	Sublegal[1] male	Legal[2] male
A	2	Ocean pots—triggers raised, escape rings open	12	12	12
B	4	Ocean pots—triggers functional, escape rings open	20	22	22
C	4	Ocean pots—triggers functional, escape rings closed	0	12	24
D	3	Bay pots—triggers functional, escape rings closed	0	9	18

[1] Sublegal size crab—less than 6¼ inches across carapace.
[2] Legal size crab—6¼ inches or more.

Table 2.—Summary of escapement and mortality by experiment for female, sublegal and legal size male crabs.

Experiment	Sex and size of crabs	No. of crabs	Days soaked held	Total escape		In-pot survival		In-pot mortality	
				No.	Percent	No.	Percent	No.	Percent
A	Female	12	11	9	75	2	17	1	8
	Sublegal size male	12	11	11	92	0	0	1	8
	Legal size male	12	11	12	100	0	0	0	0
B	Female	20	12	13	65	5	25	2	10
	Sublegal size male	22	12	17	77	1	4	4	18
	Legal size male	22	12	10	45	7	32	5	23
C	Sublegal	12	74	8	67	3	25	1	8
	Legal size male	24	74	4	17	14	58	6	25
D	Sublegal size male	9	74	6	67	1	11	2	22
	Legal size male	18	74	5	28	8	44	5	28

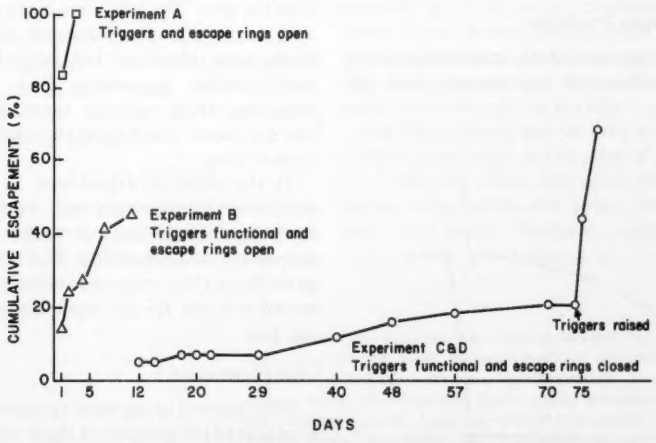

Figure 3.—Escapement of legal size male crabs in Experiments, A, B, C, and D during the study period.

Fishing for test crabs off Everett was poor; consequently, the number available for use was limited. Most of those captured were small with none of the legal size males exceeding 6¾ inches across the carapace.

All crabs collected the first day were marked and carried by divers into two ocean pots. Four visits to the pots to record escapement were made during the subsequent 11 days.

Both male and female crabs quickly exited the two pots having open tunnels and escape rings (Table 2). Of the 36 crabs, 27 (75 percent) were gone after 24 hours and 2 (6 percent) died in the pots. By the third day, all legal size males had escaped (Fig. 3), no additional mortalities occurred, and only two female crabs remained for the final 8 days.

Experiment B: Ocean Pots in Fishing Condition—Tunnel Triggers Functional and Escape Rings Open

On 9 October 1974, four ocean pots were set with tagged crabs from off Everett to obtain estimates of crab escapement from pots having the triggers functional and the escape rings open (normal fishing configuration). Like experiment A, legal size male crabs were relatively small and female crabs were generally larger than the sublegal males. The experiment was terminated after 12 days when only 20 percent of the original crabs remained alive in the four pots.

Different escape rates were observed for the three groups (Fig. 4).

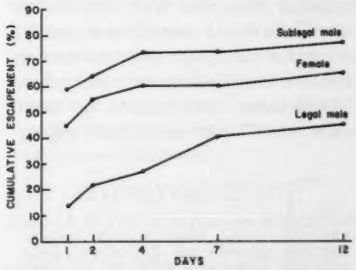

Figure 4.—Cumulative escapement of female, sublegal and legal size male crabs from pots having functional triggers and open escape rings.

Seventy-seven (77) percent of the sublegal male crabs escaped from pots having open escape rings and functional triggers in 12 days. Sixty-five (65) percent of the female crabs escaped while only 45 percent of the legal size males exited. Although no crabs were observed completing their escape, individuals from all three groups were seen maneuvering with their bodies, having nearly passed

through the escape ring. During the 12-day confinement, 11 (17 percent) of the crabs died. Octopuses were observed at the pots and may have influenced escapement.

Experiments C and D: Ocean and Bay Pots with Tunnel Triggers Functional and Escape Rings Closed.

These were planned to obtain estimates of the escape rate of crabs from ocean and bay pots having escape rings closed and triggers functional. They began after experiments A and B were terminated and the pots moved to a new location on commercial crab grounds about three-fourths of a mile away.

Crabs measuring up to 7 inches across the carapace from Willapa Bay were used. They were generally larger than those crabs taken from Puget Sound for experiments A and B. No female crabs were available.

The experiments continued uninterrupted for 74 days, after which all triggers were tied open to learn whether crabs remaining in the pots were still willing or able to escape if an easier means of egress were available.

During the first 4 weeks, the crabs became agitated when the investigators swam close to the pots. This response diminished with time and on later visits it was sometimes necessary to prod a particular crab to confirm that it was still alive and could move.

Percentage escapement for small crabs was 67 percent in both experiments while the escapement for legal size crabs, 17 percent and 28 percent, was not significantly different. Therefore experiment C and D data were combined.

Fourteen observations were made during the 74-day test. Small crabs escaped more rapidly than legal size individuals (Fig. 5). After 74 days, 67 percent sublegal and 21 percent legal size male crabs had exited through the tunnels. Of the original 64 crabs, 26 remained alive in the pots when the triggers were raised; one day later, 54 percent of these 26 remaining individuals were gone and by the third day, all but 2 had escaped.

RELATED OBSERVATIONS

In addition to reporting specific experimental results, data dealing with tags, predation, recoveries, and fish captures are presented here.

Mark Retention

The epoxy putty used for marking the crab carapace eroded with time. Some crabs lost portions of the putty lump within a few days. After soaking 74 days, about 25 percent of those crabs remaining had lost most or all of the putty mark. This did not cause a problem as crabs that lost the mark could be distinguished from several new local entries by their light color and sluggish behavior.

Octopus Predation

On the second day after commencing experiment B, the investigators discovered an octopus (about 35 pounds) on top of one pot (Fig. 6). The octopus was observed for several minutes attempting to capture crabs inside the pot. Individual arms placed through the top and side meshes readily seized various crabs which were then drawn to the meshes. The crabs were highly excited. The octopus was not observed to use two or more of its arms in a coordinated effort to move the crabs closer to its beak.

The octopus ignored all advances made by the divers and continued to probe for crabs. After forcibly removing the octopus from the pot, one dead marked crab was found held firmly against the base of the arms near its mouth. We presume it had been pulled out through the top pursed dumping hole. Two more dead crabs held up against the top meshes dropped away from the animal inside the pot.

No evidence of octopuses was found on the next visit 2 days later, but again on the seventh soaking day, octopuses weighing about 20 and 35 pounds were observed on top of two pots. Neither animal had possession of any crabs and no crabs in the pots appeared to have been killed by the animals. Again the octopuses were reluctant to be driven away.

Two octopuses were known to inhabit a small shipwreck about 150 feet from the pots. The dens were inspected after each visit to the pot string. Crab shells were observed but none had putty marks, suggesting that the octopuses which occupied these dens had not eaten crabs from the experimental pots.

At the close of experiment B, 13 marked crabs were released. Several days later, three marked shells appeared at one octopus den. There was no evidence that octopuses visited pots moved to a new site for experiments C and D.

Crab Recoveries

Some marked crabs were recovered. A total of 12 (17 percent) of those crabs which escaped during experiments A and B were recovered by local fishers. One marked crab escaped, then entered an unused pot stored among those in the study. Since we did not anticipate commercial fishing near the site of the

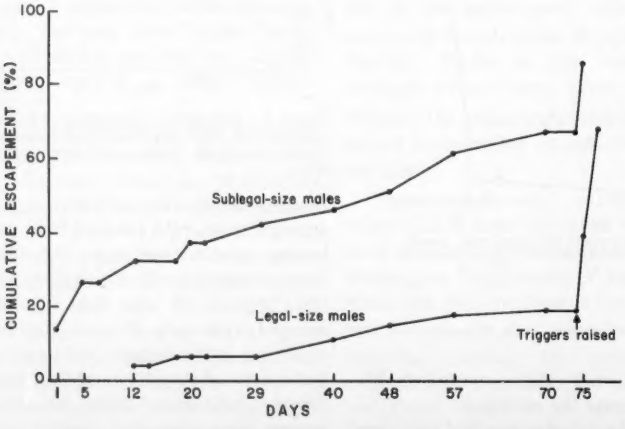

Figure 5.—Cumulative escapement of sublegal and legal size male crabs in Experiments C and D.

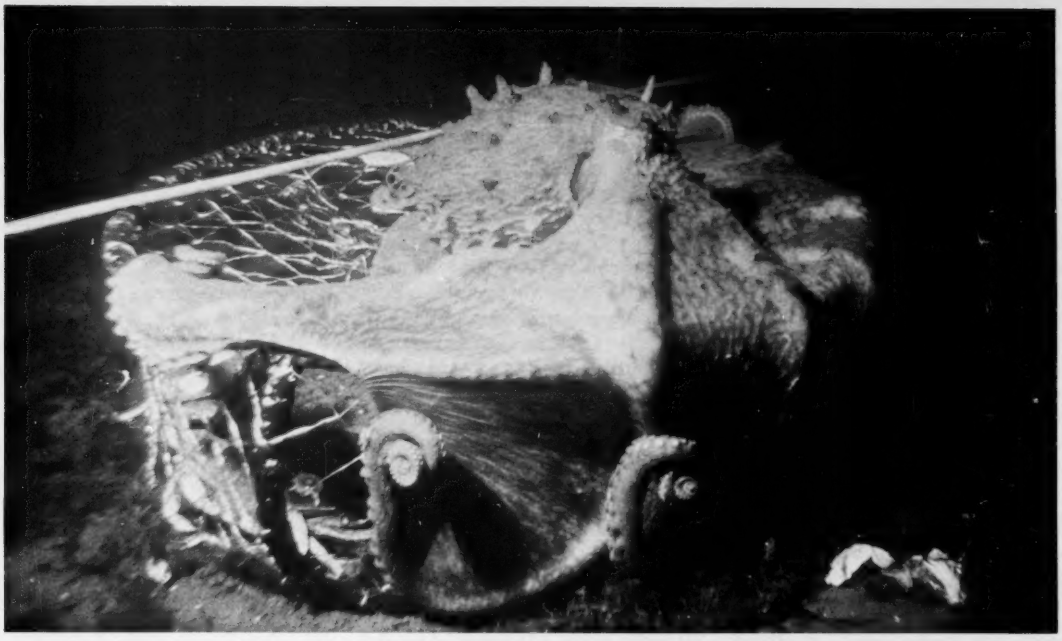

Figure 6.—An octopus is shown on top of one study pot, harrassing the crabs. The creature managed to capture three crabs.

experiment, appropriate tags for easy identification and return were not used. This relatively high incidental recovery implies that they escaped from the pots rather than being removed by octopuses or other predators.

Fish Captures

Two Pacific cod, *Gadus macrocephalus*, were found alive in separate pots containing crabs. The cod remained for several days and then apparently escaped.

CONCLUSIONS

These four experiments contribute to the general conclusion that, given an opening of sufficient size, crabs will find their way out of pots. All legal size male crabs escaped from unbaited open pots in 3 days. Escapement was reduced to 45 percent in 12 days for those required to exit through the escape ring or past triggers. With the escape ring closed, only 21 percent escaped after 74 days. Apparently those Puget Sound fishers who use open-tunneled pots (without triggers) rely on the presence of bait to "hold" crabs for short soaking periods.

It is likely that triggered pots which contain large crabs at the time of the pots' loss and those lost pots which attract large crabs will retain many until their death. Similarly, sublegal crabs egress past triggers at a relatively low rate and are subject to extended confinement.

Although we have obtained estimates of the escape rate for Dungeness crabs from pots, as yet we do not know how frequently crabs enter unbaited lost pots and become trapped. Therefore appropriate studies should be conducted on coastal commercial grounds to gather this information and to compare escape rates there with what is reported here.

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Nitrite Additives—Harmful or Necessary?

ELINOR M. RAVESI

INTRODUCTION

The use of nitrites in the preparation of smoke-cured fishery products and processed meat products dates back to 1925. Prior to that, dating back to the early beginnings of the curing process, nitrates, usually containing nitrite impurities, were used. Nitrites are used in the curing of meats to impart red color, to enhance flavor, and to protect the product from the growth of *Clostridium botulinum* in case of contamination or mishandling. In the curing of fishery products, the addition of sodium nitrite ($NaNO_2$) prior to smoking to inhibit the growth of *C. botulinum*, thereby preventing formation of its toxin, is of primary importance. In recent years, the use of nitrites has been viewed with suspicion, and the continued use of $NaNO_2$ in the food industry has become a matter of controversy. The questions arising from the use of nitrites are: 1) Is their continued use necessary for the production of a product safe from deadly bacterial toxin? 2) Is their presence responsible for the occurrence and formation of highly potent carcinogens in foodstuffs and/or in the bodies of the consumers of these foodstuffs?

In recent years, the occurrence of trace amounts of *N*-nitrosamines has been indicated in many cured meat products (Fazio, White, and Howard, 1971; Sen, 1972; Fazio et al., 1973; Panalaks, Iyengar, and Sen, 1973; Panalaks et al., 1974), cured fishery products (Ender and Ceh, 1968; Sen et al., 1970; Fazio, Damico, Howard, White, and Watts, 1971; Sen et al., 1972; Kawabata et al., 1973; Gadbois et al., 1975), in addition to other products such as cheese (Sen, Smith, Schwinghamer, and Marleau, 1969), soybean oil (Hedler et al.[1], 1971), milk (Hedler and Marquardt, 1968), alcoholic beverages (McGlashan, Walters, and McLean, 1968), and tobacco (Hoffman et al., 1974). They have also been found to occur in vivo. For a variety of animals tested in feeding studies, many of these compounds have been shown to be highly potent carcinogens (Preussmann[2], 1971; Swann and Magee, 1971; and Preussmann, 1974). The danger of these *N*-nitroso-compounds to human beings has not yet been established, as there is no direct evidence of their carcinogenicity in man. Although much remains to be learned concerning the chemistry of these compounds, they are known to form in foods and in the various organs of animals under favorable conditions of pH, time, and temperature from the reaction of secondary and tertiary amines with nitrite (Epstein[3], 1971; Hill[4], 1971; Sander and Schweinsberg[5], 1971; Cantoni, Renon, and L'Acqua, 1974; Myslivy et al., 1974). Nitrosamines have been isolated from gastric juices of animals fed these precursors and under simulated human stomach conditions (Walters, Saxby, and Newton[6], 1971; Lane, Rice, and Bailey, 1974).

The presence of several amines such as methylamine, di- and trimethylamine, di- and triethylamine, *N*-propylamine, and *N*-butylamine has been reported in a variety of fishery products (Gruger, 1972). Their occurrence, primarily a result of bacterial and enzymic action, is known to vary considerably, quantitatively and qualitatively, depending on such factors as the species and the age of the fish, as well as storage and handling conditions. They may also arise during cooking. Freshwater species of fish of

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the Great Lakes region, often used in the preparation of smoked fishery products, have higher amine contents than do marine fishes. If it is proven that the simultaneous consumption of these amines and nitrites present a real hazard to our health, then all possible steps must be taken to eliminate this hazard. By no means would it be possible for us to eliminate these amine compounds from the foods we eat. We can, however, to some extent, control the amount of nitrite we consume—at least that amount which is not a naturally occurring constituent of food.

The U.S. Food and Drug Administration (FDA) has issued regulations on the safe use of $NaNO_2$ for the preservation of smoked fishery products. As early as 1925, the U.S. Department of Agriculture (USDA) imposed an upper limit of 200 ppm residual sodium nitrite in any cured meat or fish product as it was known since the early part of this century that high doses of sodium nitrite had a toxic effect on humans causing methemoglobinemia, the result of nitrite combining with the hemoglobin of blood. Public concern and pressure for stronger and more effective food and drug control laws resulted in the enactment of the Federal Food, Drug, and Cosmetic Act of 25 June 1938. This legislation increased regulatory control over toxic substances added to food; but as the use of new food additives mushroomed, it became apparent that this law, too, was inadequate. In 1958, as a result of a study conducted by the Congressional Delaney Committee, the Food Additives Amendment of 1958 was passed. This amendment required FDA preclearance of all new food additives for safety before marketing. Prior to the passage of this amendment, when adulteration of food was charged, FDA was legally obliged to prove that the substance was poisonous; that it had been added; and that it was unnecessary in the production of the food. The Food Additives Amendment changed this situation. It shifted the burden of proof from FDA to the manufacturer, distributor, or user of a new food additive who was required to prove its safety. Under the amendment, FDA is responsible for determining the safety of all food additive uses, publishing regulations, approving such uses, and establishing safe limits referred to in the law as "tolerance limitations."

A significant feature of the Food Additives Amendment is the Delaney Clause which is intended to protect the consumer from the potential hazards of ingesting carcinogenic chemicals. FDA is prohibited by this clause from approving the use of any food additive which has been found to induce cancer when consumed by man or animal. FDA may approve a proposed use of an additive after evaluating the data submitted to it and finding that there is no doubt that the proposed use would accomplish the "intended physical or other technical effect," that is, the effect the additive may have on the sensory or other aspects of the food. The task of the FDA, in its consideration of whether the additive produces the desired effect and how much of the additive is required to produce the intended effect, does not include judging whether the effect increases the value of the product to the consumer or improves its marketability. Significantly, the amendment does not delegate to the FDA the authority to balance the benefits of a food additive against the risks associated with its use in deciding whether to approve the use. The FDA is expected only to consider whether the additive produces the intended effect and whether it is safe for human consumption.

In January 1971, the Intergovernmental Relations Subcommittee began an investigation to determine the adequacy of the protection being afforded consumers by the FDA and the USDA against potentially harmful food additives. The investigation was undertaken because of widespread public concern about the potential dangers of food additives. In March of that year, hearings focused on additives of current scientific concern such as nitrites and nitrates because of their possible conversion in food or in the body to cancer-producing nitrosamines and nitrosamides making them a potentially serious health hazard. To date, there is no conclusive evidence that nitrosation, the formation of nitrosamines from their precursors, in the human stomach causes cancer; however, cancer has been produced in test animals which had been simultaneously fed nitrites and certain secondary amines. Malignant tumors were produced in rats by a dose as low as 2 ppm of diethylnitrosamine (Committee on Government Operations, 1972). To date, a "no-effect level" has not been established for this compound. A German study (Sander and Seif, 1969), in which nitrate and the secondary amine diphenylamine were fed concurrently to human volunteers, demonstrated that both nitrosation and the reduction of nitrate to nitrite were occurring in the human body. Formation of nitrosamines in human gastric juices due to ingestion of precursors has also been demonstrated by other investigators (Sen, Smith, and Schwinghamer, 1969; and Magee, 1971). In no instance, however, was carcinogenesis established.

Nitrates and nitrites received USDA approval for use in the curing of meats years before passage of the Food Additives Amendment and were, therefore, exempt from its provisions because of "prior sanctions." However, prior sanctions may be revoked and regulatory action taken against the use of nitrates and nitrites. For food other than meats, no such prior sanction exists, and the use of nitrates and nitrites in such foods must be precleared and approved for use by FDA.

The Delaney Clause prohibits FDA from approving any food additive "if it is found to induce cancer when ingested by man or animal." Application of this clause to the nitrite situation is complicated by the fact that nitrites per se have not been found to produce cancer but rather when ingested simultaneously with certain secondary and tertiary amines have produced cancer in animals. It would appear then that the Delaney Clause is technically and legally not applicable to nitrites if a reaction takes place between nitrites and secondary amines in a man's stomach but does become applicable if it can be demonstrated that nitrosamines are produced in the meat or fish from the added nitrite and these nitrosamines are consumed.

The discovery prior to 1925 that nitrites would more efficiently produce the intended effect, namely color fixation and enhancement in meat, led to the petition of USDA by several

meat establishments to experiment with the use of nitrites. As a result of these experiments, the limit or tolerance of 200 ppm of nitrite was set. This limit was based on the maximum nitrite content found in the cured meats produced during these experiments, and it in no way pertains to the minimum quantity necessary to accomplish the intended effect. There is no justification whatsoever for this limit. A most important question to be answered then is how much nitrite is actually needed to accomplish its purpose. As little as 10 ppm of nitrite, for example, suffices to impart acceptable flavor and color to bacon; however, from a bacteriological viewpoint, this level may be inadequate.

In view of the findings of the subcommittee, the evidence that nitrites play an important role in preventing the occurrence of botulinum poisoning in meats is not exceptionally strong except in special cases such as the larger-sized canned hams. The 3- and 5-lb cans may require the addition of nitrite because the heat penetration necessary to destroy botulinum spores in meat may be difficult to achieve.

A summary (Center for Disease Control, 1974) of botulism outbreaks during the period 1899-1975 revealed only 11 (possibly 10) instances in which meat was the cause of botulinum poisoning. Beef was the vehicle in four outbreaks (in one outbreak, traced to beef stew, the actual source is unknown), pork in three, poultry in three, mutton in one, and venison in one. All of these were caused by types A and B toxins with the exception of the venison-caused outbreak which was traced to the rare type F. There has never been any reported instance of botulism attributable to fresh meat. Here the potential might seem to exist since beef is often aged at controlled temperatures for varying periods of time before cooking or curing. However, most meats are cooked prior to consumption destroying the botulium toxin and ensuring the safety of the food. The toxin is easily destroyed by heat, therefore any meat which must be cooked cannot present a hazard to the consumer. Bacon, then, would be considered a typical example.

William Lijinsky of the Carcinogenesis Program at Oak Ridge National Laboratory has done considerable research in the area of nitrosamine occurrence and detection. He is critical of the present use of nitrites stating that the permitted level of 200 ppm of nitrite leaves no margin of safety. Lijinsky has not called for a ban on the use of nitrites in the curing process but rather urges that the permitted levels of residual nitrite be brought into line by carefully determined needs rather than to be set by an arbitrarily chosen amount. If the amount of residual nitrite varies so considerably in a finished product and if the amount is so often found below 50 ppm and found to be effective at these low concentrations, why then can't lower limits be established and enforced?

More than 6,500 samples of nitrite-treated meat were tested by the USDA during the period 1 January 1970, to 31 January 1971. More than 79 percent of these samples were found to have 25 ppm or less, and 92 percent contained 50 ppm or less. Actually, the problem of how much nitrite is needed in the curing of a product and the determination of the residual nitrite that remains in the product after curing and storage are complicated, to say the least. Residual nitrite is only that amount of nitrite which can be detected by current analytical techniques. It is a superficial description and in no way explains what became of the nitrite which was incorporated into the product at the time of curing but which, during storage, "disappeared." A number of reaction pathways have been well established for the removal of free nitrite in meat products (Cassens et al., 1974); however, total losses still can't be accounted for. To be concerned with the free nitrite which might combine with amines to form nitrosamines is to be concerned with only a portion of the problem. What, for example, is the "Perigo inhibitor" (Perigo, Whiting, and Bashford, 1967)? This unknown inhibitor for the growth of several species of *Clostridium* has been found to form when certain culture media are heated in the presence of $NaNO_2$, and its inhibitory activity differs from that of nitrite alone.

If nitrites are being used with concomitant formation of nitrosamines when no danger of botulism exists or if it is found that the nitrites are being added not as a preservative but only to fix color, then it apears unquestionable that their use should be prohibited. If, on the other hand, levels of nitrite can be established which cause no nitrosamines to be formed in the product, then the use of nitrites should not be prohibited by a sweeping generalization; i.e., assuming it can be shown that there is no significant formation of nitrosamines in the stomach after ingestion of these nitrites. The FDA initiated formal action in November 1972, to ban the unnecessary and hazardous use of nitrites, an action which would seriously affect the smoked fish industry. If finalized, this action would put a stop to the use of sodium nitrite in smoked-cured sablefish, salmon, and shad, sodium nitrite in smoked tuna fish products, and potassium nitrite in cod roe. Allegedly, the additives in these instances are being added primarily as preservatives.

Following the passage of the Food Additives Amendment of 1958, the FDA imposed regulations pertaining to the use of nitrate and nitrite in smoked and cured fish products. The following regulations (Committee on Government Operations, 1972) were published.

1) Regulations 21 CFR 121.1063 and 121.1064 which permit the use of sodium nitrate and sodium nitrite in amounts not to exceed 500 parts per million of nitrate and 200 parts per million of nitrite in smoked and cured salmon, sablefish, and shad, and in home-cured meat, poultry and game, primarily for color fixation and secondarily for preservation.

2) Regulation 21 CFR 121.1132 permits the use of potassium nitrate as a curing agent in the processing of cod roe in an amount not to exceed 200 parts per million of the finished roe.

3) Regulation 21 CFR 121.223 permitting the use of sodium nitrite as a preservative and color fixative in canned pet food containing fish and meat provided that the level of sodium nitrite does not exceed 20 parts per million.

4) Regulation 21 CFR 121.1064 permitting the use of sodium nitrite as a preservative and color fixative in smoked and cured tuna fish products, provided that the level of sodium nitrite does not exceed ten parts per million in the finished product.

5) Regulation 21 CFR 121.1230 permitting the use of sodium nitrite in processing smoked chubs to aid in inhibiting the outgrowth of toxin formation from *Clostridium botulinum* type E, provided that the sodium nitrite content of the edible portion of the finished smoked product is not less than 100 parts per million and not greater than 200 parts per million as measured in the loin muscle.

Regulation (5) went into effect in August 1969. Before that date, chubs were prepared without the use of nitrites because it use was not permitted. However, after three outbreaks of botulism which were attributed to smoked chubs and which caused a number of deaths, the Bureau of Commercial Fisheries under the U.S. Department of the Interior petitioned FDA for a regulation to allow the use of $NaNO_2$ in chubs. A regulation was published which requires chubs to contain not less than 100 ppm of sodium nitrite for effective preservation against botulism and permits a maximum of 200 ppm. This regulation also carries requirements for heat processing and an adequate content of NaCl, both of which have a preservative effect. If such a level correctly reflects the minimum nitrite content necessary for protection against botulism, the effectiveness of the low levels of nitrite found by the USDA in meats as a prevention against botulism becomes questionable. Actually, the level 100 ppm is in itself open to question and closer examination may indicate a lower level of nitrite may be sufficiently effective.

Whereas FDA's survey of the meat industry revealed a preponderance of samples of low $NaNO_2$ content, i.e., much less than 200 ppm, this was not commonly the case with fish samples analyzed. In a 1969 preliminary survey conducted by FDA to determine the distribution of sodium nitrite in cold, smoked fish, six plants were inspected. Three of these firms were found to have produced smoked salmon with sodium nitrite contents in excess of 200 ppm. A 1970 survey also revealed some smoked chub samples with excessively high nitrite concentrations. This is not meant to imply that this situation is typical of most smoked fish producers. Rather, it is intended to illustrate that violations of the regulations do exist, and it is these violators who are exacerbating the problems in the use of nitrite additives for the conscientious processor of smoked fish. Violations become more common with insufficient monitoring and laxity in regulatory action. Though the maximum permitted tolerance for sodium nitrite is 200 ppm in smoked and cured fish, FDA has established 260 ppm as the action level for smoked chub. That is, seizure or other action involving smoked chub containing excess sodium nitrite will not be authorized unless the level is at least 260 ppm. The 1970 survey also revealed smoked chub samples with nitrite levels far below the minimum level of 100 ppm. Though such small concentrations of nitrite were not likely to have any significant preservative effect in the control of botulism, FDA instituted no action against any of the producers though they were in direct violation of the regulations published by the FDA.

If a safe product is to be offered to the consumer, it may be that the use of nitrites is needed. The outbreaks of botulism due to smoked fishery products are not common, but also they are not rare. A review of botulism outbreaks during the period 1899-1973 revealed the occurrence of 688 outbreaks involving a total of 1,784 cases with 978 reported deaths. Four hundred and ninety-five (72 percent) of these outbreaks have been traced to home processed foods. Only 62 (9 percent) outbreaks have been caused by commercially processed foods. The source of food responsible for the remaining outbreaks is unknown. As a vehicle responsible for botulism outbreaks, fish is relatively more important than meat. During the period 1899-1973, fishery products have been responsible for 4.4 percent of the total outbreaks, beef 0.9 percent, pork 0.4 percent, and poultry 0.4 percent. It is generally assumed that if botulism is caused by a marine product, type E toxin is responsible; but of the 29 outbreaks caused by fish products up to 1973, 19 were due to type E, 7 were due to type A, and 3 to type B.

The first reported outbreak of botulism in the U.S. due to fishery products occurred in 1932 and was caused by salmon caught and smoked in Labrador. At that time, type E strain had not yet been identified. However in 1935, type E was isolated from Russian sturgeon and was found to be identical to that strain isolated from the salmon of the 1932 outbreak and also from some imported German canned sprats which were the cause of a second outbreak in 1934.

It was in the early sixties that attention was focused on the smoked, freshwater fish of the Great Lakes region. The first known cases of botulism caused by fish caught in the Great Lakes were reported in 1960 when commercially-processed, vacuum-packed, smoked ciscoes were found to be the cause of an outbreak in Minnesota. Type E toxin was isolated. Since 1960, commercially-processed, smoked fish from the Great Lakes region has been responsible for four outbreaks of botulism which have involved 22 cases resulting in 10 deaths. In 1963, Michigan was the location of an additional outbreak of type E botulinum; but in this case, three persons were stricken after eating commercially packed, canned tuna from California. In 1963, this region was particularly hard hit. Smoked whitefish, vacuum-packed in Michigan and shipped to the adjoining states of Tennessee, Alabama, and Kentucky was the cause of 17 cases, in which 5 persons died. In this same year, two additional outbreaks occurred in Michigan and Minnesota, also due to commercially processed, smoked whitefish. In 1967, commercially packed whitefish was the cause of an outbreak in Illinois.

Type E toxin shows a widespread distribution along both the Atlantic and the Pacific coasts and in the Great Lakes Region. Alaska is the leading state (12 outbreaks) reporting type E outbreaks which is due to the popularity of certain foods such as cheese eggs or fermented salmon eggs with certain groups of native Alaskans and the widespread practice of home-processing. Up to the present, 32 outbreaks of botulism have occurred in the United States which can be attributed to fish and seafood.

Although the need for nitrite in smoke-cured fish as a means of preventing botulism has been stressed, the bacteriostatic action of nitrite is not firmly established. It is not mandatory

that processors of cured, smoked fish use nitrites in their product to prevent botulism. Sodium chloride in the concentration range 2.5 percent-5.8 percent has been reported to inhibit outgrowth and toxin production by *C. botulinum* type E (Abrahamsson, Gullmar, and Molin, 1966; Segner, Schmidt, and Boltz, 1966; Christiansen et al., 1968; Emodi and Lechowich, 1969; Lechowich, 1970). However, inhibition of outgrowth of types A and B spores requires a sodium chloride concentration of 8.2 percent-10.5 percent (Lechowich, 1970). It is generally agreed if the 180°F for 30 minutes requirement is met and the fish is subsequently distributed under adequate refrigeration with proper sanitation, there would be no need for the use of $NaNO_2$. The complaint of industry is, however, that they are not equipped to use that alternative and, moreover, use of this alternative results in a product showing excessive thermal damage. Also, the possibility that heat resistant mutants may evolve must not be overlooked. In 1953, a team of investigators (Dolman and Chang, 1953) reported survivors among type E spores heated at 212°F (100°C) for 30 minutes. A second alternative would be to heat the product to an internal temperature of 150°F for 30 minutes and have a minimum of 5 percent salt in the water phase. It is generally felt, however, that this produces a product that is too salty. (This is the problem which now confronts the meat and fish industries.)

The controversial status of nitrites during recent years has resulted in extensive testing of a variety of meat and fishery products by a number of institutions, government and academic, and private industry for nitrosamine occurrence. Analyses of various cured meat products have disclosed the presence of nitrosamines in many. A concentration of dimethylnitrosamine (DMNA) has been detected in some ham samples at the 5 parts per billion (ppb) level (Fazio, White, and Howard, 1971). In other samples, it was nonexistent.

Investigators of the Food Research Division in Ottawa have made a study of numerous cured meat products with regard to their nitrite and nitrosamine contents. In one study (Panalaks, Iyengar, and Sen, 1973), 197 samples of various kinds of meat products were tested. Of these, 57 samples indicated trace amounts (2-12 ppb) of DMNA. These included such products as ham spread, luncheon meat, ox tongue, wieners, bologna, Polish and Ukranian sausage, salami, pastrami, and bacon. Others were negative. No mass spectrometric confirmation of the identity of DMNA was carried out so results should be considered as only tentative. In only a few types of meat products did the concentrations of nitrate and nitrite correlate with that of DMNA detected in the samples. In a later study by this same group (Panalaks et al., 1974), of a total of 80 samples of different kinds of cured meat products, 17 contained 13-105 ppb nitrosopyrrolidine (NP_y); 29 samples contained 2-35 ppb DMNA; and 9 samples contained 2-25 ppb diethylnitrosamine (DENA). In a few cases, identities were confirmed by gas-liquid chromotography (GLC) and mass spectrometry.

Scientists with the USDA and FDA have investigated the volatile nitrosamine content of bacon. High *N*-nitrosopyrrolidine concentrations in this product have been reported. The FDA investigators (Fazio et al., 1973) reported levels isolated from 8 commercial brands ranging from 10-108 ppb. This potent carcinogen was found in the cooked product but not in the raw form. Fat remaining in the pan after frying also contained nitrosopyrrolidine at levels ranging from 45-207 ppb. Since approximately 1.5 billion pounds of bacon are consumed each year, the presence of this nitrosamine in such a popular product deserves much consideration. Studies (Pensabene et al., 1974) investigating the effect of levels of sodium nitrite and cooking on the formation of NP_y indicate that the concentration of this nitrosamine increases with increasing nitrite levels. Samples which were pan fried showed the highest concentration of NP_y, while microwave-cooked samples showed the least. Concentrations of NP_y appeared to be dependent upon the frying temperature.

In a German study (Nagata and Mirna, 1974) which was carried out to determine the effects of processing conditions on the concentration of nitrosamines in meat products, it was concluded that nitrosamine formation was influenced mainly by heat treatment (sterilization, roasting, frying), but not by pH. No effects of bacterial fermentation, increased salting, or increased addition of pepper or paprika was observed. No increase in nitrosamine concentration attributable to dry salting was noted except in bacon which contained 45 ppm nitrosamines—mainly dimethyl-, diethyl-, piperidine, and pyrrolidine derivatives. No relationship was observed between residual nitrate or nitrite concentration and nitrosamine content. Addition of ascorbic acid or its sodium salt resulted in increased concentrations of nitrosopyrrolidine. This is in contrast to other studies which have shown that the addition of ascorbic acid has acted to decrease the amount of nitrosamines formed in nitrite-treated meat products (Mirvish et al., 1972; Kawabata et al., 1973; Fan and Tannenbaum, 1973; Fiddler et al., 1973; and Mottram et al., 1975).

The quantity of cured meat consumed in this country is high. Approximately 70 percent of all pork produced annually in the United States is cured. The per capita consumption of pork in 1974 was 66.5 pounds which means an average of 46.5 pounds of cured pork was consumed by each person. This is more than 90 times the amount of cured fish which is consumed. As a nation, we consumed about 2 billion pounds of wieners and bologna in 1973, plus 66 million pounds of smoked or dried beef, and 230 million pounds of cured beef.

The quantity of cured fish consumed per capita annually in this country is small compared to that of meat. Of the total per capita consumption of 12.0 pounds of all types of fish, only 0.5 pound of cured fish is consumed. This has not fluctuated greatly over the last 25 years, ranging between 0.4 and 0.7 pounds. This does not lessen the responsibility of the fish processor to insure a safe product to the consumer; however, it would seem to indicate that he could expect the same or equal judgment on his product as that which the processor of cured meat products receives.

Although cured fish has come under investigation the same as has cured

meat, the nitrosamine concentrations found in any species have been relatively low compared to those isolated and measured in some meat products. Investigators at FDA have isolated and confirmed by mass spectrometry levels of DMNA ranging from 4 to 26 ppb from samples of raw, smoked, and smoked nitrite- and/or nitrate-treated sable, salmon, and shad (Fazio, Damico, et al., 1971). Though no nitrosamine was detected in the raw salmon and shad, in the raw sable a level of 4 ppb was measured. In a separate study (Howard, Fazio, and Watts, 1970) conducted by this same group on smoked, nitrite-treated chub, such very low levels of 1-2 ppb detected (demonstrated sensitivity of method 10 ppb) led to the conclusion that DMNA was not formed under processing conditions in the nitrite-treated fish. Even fortification of the fish with large amounts of trimethylamine hydrochloride (1,500 ppm) and treatment with nitrite at high levels (2,500 ppm) prior to smoking did not cause an increase in the apparent amount of DMNA. Nitrosamine studies conducted at the Northeast Utilization Research Center of the National Marine Fisheries Service have also revealed the presence of only trace amounts (<10 ppb) of DMNA in cold-smoked sablefish to which had been added nitrite at levels ranging from 0 to 550 ppm (Gadbois et al., 1975). Concentrations of DMNA in these samples showed no apparent increase when samples were stored for two weeks at refrigerated temperatures (40°F). Twenty-four samples of various salmon roe products packed by Japanese producers were also investigated by this group. The presence of DMNA in all samples analyzed was too low for confirmation. Twenty-three commercially prepared salted Alaska pollock roe samples analyzed for nitrosamines by a Japanese team of scientists showed almost no DMNA (Kawabata et al., 1973). In most cases, it was below or around the detection limit of 1 ppb, except in one sample from which 6.7 ppb DMNA was detected.

The FDA has placed the use of nitrite in both hot-smoked fish and cold-smoked fish processes under interim food additive regulation until tests are completed to establish the safety and the need for the preservative. The agency had been expected to ban use of nitrite in the hot-smoked fish process, but FDA officials granted an extension after concern was expressed that present temperature and other requirements may not be effective to control *C. botulinum* types A and B without the use of nitrites. The FDA believes that type E can be controlled without nitrites, but is not as certain about the more heat-resistant types A and B. Studies on the effect of nitrite on outgrowth and toxin production by *C. botulinum* in hot- and cold-smoked fishery products are being conducted by the National Marine Fisheries Service.

The formation of *N*-nitroso compounds in food products and in biological systems is not completely understood. A problem of nitrosamine research is the minute occurrence of these substances in food. Not only are these compounds elusive in behavior, but their detection is most tedious. Occurrences at the parts per billion level make their extraction and isolation necessarily exacting, and techniques currently being used could benefit from improvements. No doubt, many erroneous results have been reported, and initial findings should be confirmed. The problem of nitrites and nitrosamines today calls for vast amounts of additional research in all areas—detection, formation, and the establishment of tolerance limits.

Nitrite additives—harmful or necessary? They may be both, but a cooperative effort must be made by private industry and federal officials before a more comprehensive answer can be given.

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National Registry of Marine Pathology Opens, Seeks Fish Disease Information

A depository for information on diseases and abnormalities of marine and estuarine organisms and animals, the first of its kind in the United States, has been established by the National Oceanic and Atmospheric Administration (NOAA) at the Middle Atlantic Coastal Fisheries Center laboratory, Oxford, Md.

The National Registry of Marine Pathology makes available to marine and estuarine biologists and pathologists a central reference collection of clinical, illustrative, and published material related to diseases of marine and estuarine vertebrate and invertebrate life. The Registry is maintained by NOAA's National Marine Fisheries Service. Its curator is Haskel S. Tubiash.

"We are soliciting, cataloging, and maintaining information on fish diseases obtained from many sources and will have pertinent references to published literature in a safe, permanent repository where the scientific community can deposit, retrieve, and study these materials," Tubiash said.

At present the Commerce Department facility consists of slide collections illustrating pathology, parasitism, or anomalies in species of bivalve mollusks; fishes; and decapod crustaceans. The collections represent domestic and exotic diseases of bivalve mollusks encountered during more than 10 years of surveys and diagnostic services of parasites in fishes from Raritan Bay, N.J.

The Oxford Laboratory specializes in diseases of marine and estuarine organisms and animals and has ample facilities for histological preparation, light and electron microscopy, and photomicrography. In addition, the laboratory has a library and reference collection including about 150 serial publications oriented toward marine biology and pathology. These facilities are available to the Registry and to users of the Registry by special arrangements. Qualified investigators are invited to donate suitable material to the Registry and to use the facilities.

Fish Protein Concentrate Data Package Published

A reference package providing easy access to 12 years of research which resulted in a high-quality, low-cost protein concentrate from fish has been published for public use by the National Oceanic and Atmospheric Administration's National Marine Fisheries Service.

Fish Protein Concentrate is produced by removing from fish essentially all of their fat and moisture. This yields a high-protein concentrate that possesses unique nutritional value as a food supplement.

From 1961 to 1973 the Commerce Department agency engaged in and sponsored research which developed information on the production and use of FPC. The FPC Information Package will provide the user, whether scientist, commercial investigator, or layman, with documentation of that research.

To simplify finding information in the package, it has been divided into four parts, the first three of which are in print, and the fourth on microfilm. The printed and microfilm portions of the package are available separately, or may be ordered together.

Part 1 provides a summary statement for each of six categories: General, Product Characteristics, Product Uses, Industrial/Economic Aspects, Laboratory Processes, and Production Processes. The summary statement for each category includes an overview of the data and information available in that category, the work pursued by NMFS, significant successes and failures, and, where appropriate, recommended future investigations and follow-up work.

Part 2 is the selected NMFS FPC Bibliography, listed by title, author, type of document, and call number. Included are published and unpublished articles and manuscripts; contractor final reports and, if significant, interim reports; internal NMFS reports and memoranda; and, miscellaneous titles from speeches, papers presented at various conferences, and other materials.

Part 3 of the report contains abstracts of selected documents considered to be of particular significance in the FPC Program.

The microfilm portion of the FPC Information Package represents Part 4: Selected Documentation. Documents determined to be of prime importance, particularly with regard to their detailed contents, have been microfilmed in their entirety.

The Fish Protein Concentrate Information Package may be ordered from the National Technical Information Service, 5285 Port Royal Road, Springfield, VA 22161. The paper copy of Parts 1, 2, and 3, Order No. PB245-345, is $8.75, with a foreign rate of $11.25 (microfiche is $2.25, foreign rate is $3.75). The microfilm portion Part 4 may be obtained on a 16mm plain reel for $6.00 (Order No. PB245-346) or a cartridge for $8.00 (Order No. PB245-347). Recordak, 3M, or Threadeasy should be specified.

Hawaiian Firm Joins Quality Fish Program

A voluntary inspection program conducted by the National Oceanic and Atmospheric Administration (NOAA) to assure high quality in fisheries products has been adopted by a Hawaiian food processor. Under the program, Red and White Foods, Inc., of Honolulu will be permitted to place a "Packed Under Federal Inspection" (PUFI) mark on its products. The mark attests that the product has been statistically sampled at the time of processing and found to be safe, wholesome, and of good quality.

To meet the high standards required to display the PUFI symbol, a processor of fish products must agree to inspection by a Department of Commerce representative who insures that the conditions under which the products are processed meet high sanitary requirements. All costs of the inspection program are carried by the

participating firm. A growing number of processors throughout the United States are joining the program, NOAA officials said.

Red and White Foods is the first Hawaiian processor to enter the program. The firm produces nine products which are distributed in Hawaii, the U.S. mainland, and Canada. The inspection program is managed by NOAA's National Marine Fisheries Service.

Satellite Monitors Great Lakes Chlorophyll

Chlorophyll, the substance which makes plants green and is used in deodorants, has the potential for an even greater contribution to mankind. Alan E. Strong of the National Oceanic and Atmospheric Administration (NOAA) reports that for the first time chlorophyll distributions in surface waters have been determined by satellite observation. This, he concluded, could lead to helping pinpoint productive fishing grounds with instruments aboard satellites. He presented a paper on his observations at the fall (1975) meeting of the American Geophysical Union in San Francisco.

During the past summer and fall, according to the Commerce Department agency's scientist, he was able to identify chlorophyll concentrations in algae in the Great Lakes by using reflected infrared data from NASA's LANDSAT satellite. Chlorophyll in the algae reflected solar radiation which was picked up by sensors aboard LANDSAT, Strong said.

Where living algae exists in water, the NOAA researcher said, chlorophyll will be found. More importantly, many kinds of fish tend to congregate in algae-rich waters, feeding on the algae.

If areas of high algae concentration in fresh and salt water can be monitored, and that information made available to commercial fishermen, the benefits are obvious according to Strong, who is assigned to NOAA's National Environmental Satellite Service. He stressed that at the present time satellite measurements of chlorophyll are only possible where high levels of algae exist in near surface waters.

Strong's research substantiates that of other NOAA scientists who have observed that successful fishing will not generally be found in areas where cold, subsurface waters rise to the surface, but in regions where this upwelling mixes with warmer, surface waters. Chlorophyll concentrations, and hence algae, identified by Strong were low in upwelling areas, but increased quickly as the colder water mixed with surface waters.

Within several years, he said, NOAA expects to have access to data from the National Aeronautics and Space Adminstration environmental research satellite, NIMBUS-G. This spacecraft will permit more quantitative measurements of chlorophyll in addition to measurements at much lower concentrations than is now possible with LANDSAT.

U.S. Food Fish Demand Up, Catch Down In 1975

The demand for food fish commodities in the United States increased during the third quarter of 1975, according to an economic analysis released in mid-January by the National Oceanic and Atmospheric Administration. However, consumption was reduced because of decreased supply and increased prices during the quarter.

The Commerce Department's National Marine Fisheries Service indicated that during 1975 the domestic fisher's catch of cod, flounder, ocean perch, tuna, and salmon dropped while haddock catches rose. Although catches have been low overseas, U.S. imports of most frozen products—including fish blocks, fish fillets, and halibut—increased during the period January to September 1975. This caused a substantial reduction of foreign inventories.

Imports of canned fishery products, on the other hand, were fewer than a year ago. Canned tuna imports were off one percent, canned salmon fell 60 percent, and canned sardines were down 53 percent from last year.

New supplies in some cases were well below the quantities used and caused a drastic reduction in domestic inventories. Inventory declines of other products this year reflect the industry's efforts to reduce inventories to a more manageable level. Although inventories normally increase during the first three quarters of a year, the total quantities of saltwater fish held in cold storage dropped 25 percent from 1 January to 30 September 1975. Specifically, inventories of frozen blocks of fish declined 20 percent, total fillet stocks fell 37 percent, and sticks and portions holdings fell 22 percent from the first of the year.

Because of the decline of new products and heavier demand, prices for fillets, halibut, and canned sardines increased. Prices for other products remained stable except for a drop in the price of lightmeat canned tuna.

The outlook is for a further decline in new supplies, which will result in higher prices and reduced consumption. The season for peak landings in the United States and abroad has passed. With lower inventories overseas, the prospect for a substantial increase in imports is dim. It is expected, however, that projected lower prices for beef in the coming months will affect the seafood market and will probably moderate the expected price increases for seafood products.

Copies of the report may be obtained from the Economic and Marketing Research Division, National Marine Fisheries Service, Washington, D.C. 20235.

Awards Presented for Service to Fisheries

Awards, including the Department of Commerce Gold Medal to Gerald B. Collins, a Unit Citation to the NMFS Northwest Fisheries Center, and "Service to Fisheries" plaques to NOAA Administrator Robert M. White, were officially presented in October 1975.

Collins, then a research scientist with the NMFS Northwest Fisheries Center, received the Commerce Department's highest honor, the Gold Medal, in a Washington, D.C. ceremony on 21 October for his major contribution to fishery science and administration. He was one of six Commerce Department employees receiving the award.

Now retired, Collins spearheaded re-

search on anadromous fish passage in the Columbia River and its major tributaries for over 25 years. He initiated an adult salmon behavioral laboratory at Bonneville Dam on the Lower Columbia, resulting in advances in man's knowledge of fish physiology and performance in fishways. Earlier in 1975 he proposed a program of transporting juvenile fish from the Snake River to downstream release points below the lowest dams in the Columbia River. This program is expected to increase the survival rate of steelhead trout and spring chinook salmon.

Collins received his doctorate in biology from Harvard University and entered Federal Service in 1939. He was Director of the Coastal Zone and Estuarine Studies (CZES) Division of the Northwest Fisheries Center.

On 1 October, NOAA Administrator Robert M. White presented a Unit Citation plaque to Dayton L. Alverson, Director of the Northwest Fisheries Center, in a ceremony at the Center. With 211 members, the Center is the largest group so recognized. The award was for outstanding contributions to the NOAA/NMFS programs in the following areas: 1) International Fisheries Activities and Law of the Sea; 2) Fisheries Development and Conservation Engineering; 3) Columbia River Basin Studies; 4) Environmental Conservation Studies; and 5) Reporting and Publishing of Research Results.

Following that presentation, White was given plaques for "Service to Fisheries" by William Saletic, representing the Pacific Northwest commercial fishing industry, and by Edward Manary, president of the Northwest Steelheaders, representing sport fishermen.

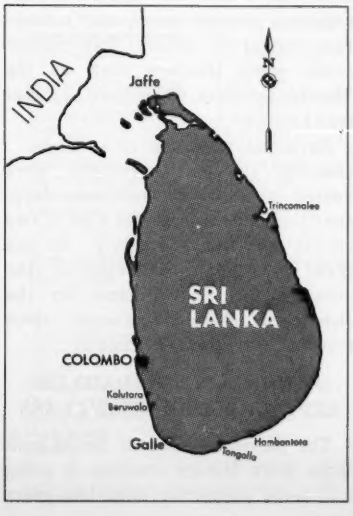
Foreign Fishery Developments

Sri Lanka Develops Marine Fisheries

The Asian Development Bank has loaned the Government of Sri Lanka $3.1 million to finance the foreign exchange costs of a fisheries development project. The Sri Lanka project aims at promoting the development of coastal and offshore fisheries by exploiting stocks of pelagic fish resources 30-100 miles from the coast. New vessels to be acquired under the project are: 200 28-foot vessels; 30 38-foot vessels; and two 60-foot stern trawlers. Training and technical guidance are also included as part of the project, which is to be completed by the end of 1978. (Source: U.S. Embassy, Colombo.).

According to the NMFS Office of International Fisheries, Sri Lanka's fisheries production reached the 100,000 metric ton level in 1972. Fully 98 percent of 1974 production was from coastal (99,000 metric tons) and inland (8,000 metric tons) fisheries. The remainder was the deep-sea fisheries catch of approximately 2,000 metric tons. Present annual domestic production is insufficient to supply local demand and about 17,000 metric tons of processed fish are imported each year.

At present, the fishing fleet exploiting the coastal fisheries of the island nation consists of about 17,000 non-powered craft, about 4,400 small craft mechanized with outboard motors up to 20 horsepower, about 2,100 28-foot FRP or wood vessels and 27 37½-foot steel vessels. In addition to the coastal fishing fleet, two 317-ton tuna vessels operate in the Indian Ocean and five 240-ton trawlers operate on the Wadge Bank off India's coast.



Colombo and Galle are the principal fishery ports. Fishery harbors are under construction at Beruwela, Mirissa, and Tangalla in the south, and at Trincomalee in the northeast. Freezing and cold storage facilities for fish are already available in Colombo and Galle; such facilities are planned for Beruwela, Mirissa, Tangalla, and Trincomalee.

Sri Lanka's fisheries project is designed to cut down the imports of fish by promoting the development of coastal and offshore fisheries. The general area of the fishery to be developed is along the southern coast of Sri Lanka, south of Colombo from Kalutara to Hambantota. Two 60-foot trawlers will operate, in a pilot program, from Trincomalee on the northeast coast.

The Fishery Cooperatives of Sri Lanka will receive loans from the Bank of Ceylon and the Peoples Bank to enable them to acquire fishing vessels, engines, fittings, gear, and navigational equipment.

Greenland Demands Fishery Extension to 100 Miles

The Executive Committee of the Greenland Council met with the Minister for Greenland on 26-27 November 1975, and the Council demanded the immediate extension of Greenland's fisheries limit to 100 miles. The demand was prompted by a recent increase of foreign shrimp fishing in Greenland's waters, particularly by the Faeroese, Soviets, and Spanish.

Greenland's traditional fishing income was based on cod and salmon until recently, but the shortages of both cod and salmon, and the resultant quota restrictions of those species, led the Greenlanders to fish for shrimp. Their major fishing income is now from this species, and a peeling and canning industry has been developed in recent years. Fishers catch a majority of the shrimp in Disko Bay (west-central Greenland), but the rapid expansion of the international shrimp fleet in the outer Greenland waters has raised

concerns over the possibility of depletion of stocks. According to a Greenland Ministry source, the demand for an extended fisheries jurisdiction is based solely on that island's concern with the depletion of its shrimp stock.

The Danish Minister for Greenland refused the demand, and advised the Council to await the outcome of the upcoming U.N. Law of the Sea Conference. However, the Council did force him to agree to promise to press for a fisheries limit of 200 miles if the LOS Conference failed to reach an accord.

The Minister also reportedly agreed to make arrangements for bilateral consultations with nations fishing for shrimp off Greenland's coast, and to appeal to members of the International Commission for Northwest Atlantic Fisheries (ICNAF) to limit fishing off Greenland.

The Minister also agreed to determine the possibility of arranging for special Danish inspectors to board foreign vessels fishing in Greenland's waters, and to investigate the possibility of increasing Greenland's salmon quota. The Minister's pledge on these various matters is subject to Government approval, and the Danish Government is reportedly discussing these issues now.

According to the NMFS Office of International Fisheries, there are growing problems between the Danes and Greenlanders. In 1974, Denmark voted to enter the Common Market, even though the majority of the people of Greenland were opposed to the idea. Denmark also placed a limit on Greenland's salmon catch, over the strong opposition of the Greenlanders. In turn, the former colony has recently shocked the Danish Government by claiming that all mineral resources belong exclusively to the people of Greenland. (Sources: U.S. Embassy, Copenhagen, and news reports.)

Russians Test, Place Three New Classes of Stern Trawlers into Serial Production

After undergoing tests and sea trials, three new classes of stern trawlers have been placed into serial production by the Soviet Union. They include the *Gorizont*, *Barentsevo More*, and *Meridian* classes.

GORIZONT-CLASS TRAWLER SUPERCEDES *ALTAI* SERIES

The new *Gorizont*-class of large stern freezer trawlers, on the drawing boards since the early 1970's, was designed to supersede the older *Altai*-class stern trawlers, which have a smaller processing and storage capacity. For example, *Gorizont*-class vessels can process a maximum 90 metric tons of fish in 24 hours and store up to 2,000 metric tons in freezer holds, but *Altai* vessels can only process 50 metric tons in 24 hours and store a total of 1,500 metric tons. The *Altai* series was disadvantaged by high maintenance costs, with some vessels spending as much as 65 percent of potential operational time in repair shipyards.

Intended for use by the Soviet high-seas fishing fleet, *Gorizont*-class trawlers are equipped with the latest technology in trawling gear, hydroacoustic fish-finding equipment, and modern processing lines. The class is one of the first to utilize the new "Dubl' " trawling system in which two trawls are operated alternately so that no time is lost in hauling and resetting the nets. As one trawl is hauled, the other one is set. The *Gorizont* vessels are fitted for both mid-water and bottom trawling at depths of up to 1,500 meters. Two processing lines produce canned and frozen fish; a fish meal and industrial fish oil plant is also located aboard. Frozen products can be stored in cold-storage holds, where a constant temperature of -28°C (7°F) is maintained; maximum storage capacity is 2,000 metric tons. Table 1 gives the basic specifications of the *Gorizont*-class large stern factory trawlers.

Table 1.—Basic specifications, *Gorizont*-class stern trawler.

Gross register tonnage	5,500 GRT
Deadweight tonnage	3,050 DWT
Displacement	7,950 DPL
Length	112.8 meters
Width (Beam)	17.3 meters
Draft (Full displacement)	6.8 meters
Speed (Maximum)	15 knots
Horsepower	7,000 h.p.
Endurance	100 days, 5,000 miles

The prototype of the new class, the *Gorizont*,[1] collided with a Moroccan freighter and sank in the English Channel on November 26. This vessel was built at the Okean Shipyard in Nikolaev on the Black Sea and was commissioned in 1975. The *Gorizont* was apparently on a shakedown cruise to test its fishing gear when the accident occurred. Other Soviet vessels in the area warned foreign ships to stay clear and rescued the crew. No casualties were reported.

[1]The name of the first fishing vessel of a new Soviet class usually becomes the name of the entire class.

BARENTSEVO MORE CLASS GOES INTO SERIAL PRODUCTION

The *Barentsevo More* class of small stern trawlers, commissioned in 1973 and designed to replace the obsolete steam trawlers used in the Barents Sea, is going into serial production at the Baltija shipyard in Klaipeda, Lithuania. This class has the latest Soviet electronic navigational and fish finding equipment, and many of the on-board fish cleaning and dressing operations are automated. The main products processed aboard are chilled and salted fish, although some canned fish and semi-processed medicinal oil are also produced. The average daily catch capability is estimated to be about 10 metric tons.

The chief advantages of the *Barentsevo More* are its larger storage capacity, greater speed, and a trawl ramp longer (27 meters) than conventional stern trawlers such as the *Maiakovskii* class, which have 19-meter trawl ramps.

Equipped with the new "Dubl' " trawling system, *Barentsevo More* vessels can carry out continuous deep-sea fishing operations with a set of two trawls operated alternately. As one trawl is hauled in and emptied, the other is set. Specifications for the *Barentsevo More*-class small stern trawlers are shown in Table 2.

MERIDIAN-CLASS TRAWLERS REPLACE *MAIAKOVSKII* CLASS

The *Meridian* class of Soviet-built large stern factory trawlers is going into serial production after two years

of extensive prototype testing and sea trials. To be constructed at the Chernomorskii Shipyards in Nikolaev on the Black Sea, this class is designed to supersede the older *Maiakovskii*-class conventional stern trawlers. *Meridian* vessels have larger holds and a greater processing capability than the *Maiakovskii* class. For example, freezer storage capacity in *Meridian*-class trawlers is 1,500 metric tons, over 1.5 times the *Maiakovskii* hold capacity of 900 metric tons. The processing potential for this class is double that of the older trawlers: *Meridian* vessels can produce 60 metric tons of frozen fish a day, whereas the *Maiakovskii* class produce a maximum of only 30 metric tons per day.

The high degree of mechanization and automation aboard the new trawlers permits a 15-20 percent reduction in crew. Thanks to greater storage capacity for provisions, water, and fuel, their potential cruising range (endurance) has increased from an 80-day maximum for the *Maiakovskii* class to 170 days, making the *Meridian* class an important addition to the Soviet high-seas fishing fleet.

Other innovations in the new class include the extension of the stern trawl ramp to 43 meters (from 19 meters for the *Maiakovskii* class) and the new "Dubl' " trawling system. The "Dubl' " system employs two trawls operating alternately. As one trawl is hauled in, the other is set, so fishing can be carried on without interruption.

Table 2.—Basic specifications, *Barentsevo More*-class stern trawler.

Gross register tonnage	1,503 GRT
Deadweight tonnage	601 DWT
Displacement	1,940 DPL
Draft	4.87 meters
Length	52 meters
Width (Beam)	13 meters
Speed (Maximum)	13 knots
Horsepower	2,000 h.p.
Endurance	33 days

Table 3.—Basic specifications, *Meridian*-class stern trawler.

Gross register tonnage	4,000 GRT[1]
Deadweight tonnage	1,980 DWT
Displacement	5,720 DPL
Length	103.1 meters
Width (Beam)	16.0 meters
Draft (Full displacement)	5.8 meters
Speed (Maximum)	14.5 knots
Horsepower	6,000 h.p.
Endurance	170 days, 7,000 miles

[1] Unconfirmed.

The prototype for the *Meridian* class was also built at the Chernomorskii Yards in Nikolaev. Launched in 1973, this vessel was tested for nearly two years before being commissioned in late 1974. The trials took place off Africa and apprently were successful, since the new class has now been approved for serial production. Specifications for the *Meridian*-class large stern factory trawlers are shown in Table 3.

MEXICAN ABALONE FISHERY THREATENED

The Mexican abalone fishery was started in the 1860's and is primarily based on two species: "pink" and "green" abalone[1]. Together they constitute about 90 percent of the total Mexican abalone catch. The remaining 10 percent of the catch is composed of three species referred to locally as "chino," "rayado," and "negro."

Almost 85 percent of Mexico's abalone resource is concentrated in the central area of the Baja Peninsula south of Cedros Island (Fig. 1). The

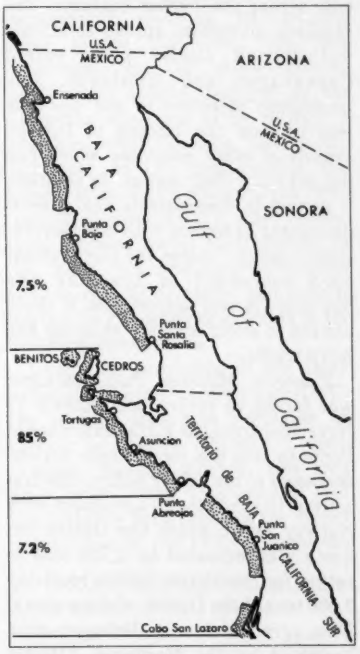


Figure 1.—Mexico's abalone grounds. Stippling indicates areas of high abalone concentration. The portion of Mexico's total abalone catch is indicated in the left-hand margin of the map.

abalone catch in 1973 was only 4.7 metric tons, a decline of 43 percent from the 8.2 metric tons harvested in 1968 (see table).

[1] In Mexico, these two species are referred to as "amarillo" and "azul," meaning "yellow" and "blue" abalone.

As the result of intensive fishing, abalone off Mexico's Baja Peninsula has been sharply reduced in abundance, according to Luis Kasuga Osaka, Director of the Mexican Fisheries Institute (INP). Abalone is one of the species reserved to Mexico's cooperative fishers and has proven a lucrative fishery. Each group of three fishers is capable of catching about 100 kg of abalone daily, bringing about 3,000 pesos (US $240), or 1,000 pesos per fisher.

Director Kasuga is afraid that such high earnings could cause the decimation of Mexico's abalone resource. He points out that in Japan, abalone was so depleted that it was necessary to construct special culturing sites. The INP maintains a supply of 300,000 abalones in case the construction of culturing sites becomes necessary in Mexico.

Director Kasuga has recommended that a seasonal closure on harvesting abalone be enforced during the summer months when the species reproduces. He considers the preservation of abalone a critical issue, as the mollusk is only found off Mexico, New Zealand, South Africa, Japan, and California.

The actual status of the abalone resource, however, is even more serious than revealed by the declining

Mexico's abalone catch (1,000 metric tons), value (US$1,000), and prices (US$/kg) from 1960 to 1973.[1]

Year	Catch	Value	Price
1960	6.0	—	—[2]
1961	6.4	—	—
1962	7.1	—	—
1963	8.3	2,231	—
1964	7.6	2,038	—
1965	7.8	2,108	—
1966	6.7	1,806	6.45
1967	6.4	1,852	6.76
1968	8.2	2,380	7.00
1969	6.9	2,004	6.91
1970	6.7	1,847	6.60
1971	6.4	1,902	6.56
1972	5.4	2,333	10.60
1973	4.7	1,992	9.96

[1] Source: "Yearbook of Fishery Statistics," FAO.
[2] Data prior to 1966 not available.

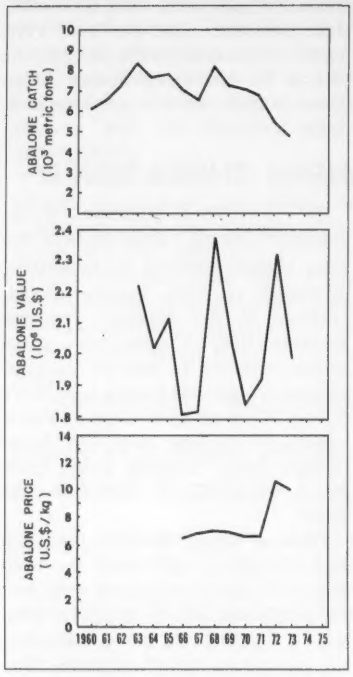


Figure 2.—Mexico's abalone catch, value, and prices, 1960-73, from FAO's "Yearbook of Fishery Statistics" (various years).

catch data (Fig. 2). According to studies conducted by Mexican biologists, almost 40 percent of the abalone currently harvested in one of Baja California's most productive abalone grounds is below the legal size. In another area the percentage of undersized abalone was even larger. The harvesting of such a large proportion of undersized abalones means that many abalone are taken before they reach sexual maturity and are thus unable to propagate the species.

The situation is further complicated because Mexican fishers traditionally shell abalone at sea in order to transport more of the meat in their small boats. This custom makes it extremely difficult for Mexican fishery authorities to adequately enforce the regulations prohibiting the harvest of small-sized abalone shells. As one Mexican biologist stated, "...to try to control the size of harvested abalone by the size of its meat is like attempting to infer the length of a fish by weighing its fillets."

The value of Mexican abalone landings since 1963 (see table) has remained stable at around US$2 million, but varied from a high of US$2.4 million in 1968 to a low of US$1.8 million in 1966.

The rapid increase in the price of abalone, which showed a small decline in 1973 after the sharp increase between 1971 and 1972 (see table), has prevented the declining catch levels from drastically reducing the total value of abalone landings. (Sources: *El Sol*, Mexico City; *Gaeeta Cooperativa*; FAO Yearbook of Fishery Statistics.

Danish Blockade Fishing Ports

A total blockade of fishing ports in Denmark was established on 13 November 1975 by independent fishers dissatisfied with the prohibition on further herring and cod fishing in the North Sea which the Minister for Fisheries Poul Dalsager announced in mid-November, when the Danish quota was filled.

Started by fishers in the North Jutland ports of Esbjerg and Hanstholm, who tied their vessels side by side across the harbor entrance, the blockade movement spread to include virtually all Danish ports except Copenhagen and Helsingør. The immediate objective of the blockade was to stop the landing of fish by vessels of other countries which had not yet filled their quotas. In addition, it served to demonstrate the general discontent of fishers with the Government's policy. Unless the Government soon succeeded in breaking the blockade, it was feared that it could expand to affect ordinary shipping and ferry traffic.

Fisheries Minister Poul Dalsager was forced to return prematurely 15 November from the FAO conference in Rome to face the increasingly serious challenge to his fishing policy. His first act was to announce an agreement with Norway under which the Danish cod quota was increased by 2,500 tons in return for Norwegian fishers receiving 7,500 tons of the Danish whiting quota. This agreement was, Dalsager said, approved by the Northeast Atlantic Fisheries Commission, which was then meeting in London.

This modest quota increase—about one week's normal catch for the Danish fishing fleet—was not accepted by the fishers. They had long been opposed to foreign-flag vessels being permitted to land fish in Denmark (some of them are able to sell their fish at advantageous prices since they are not bound by the EEC subsidy system) and they were determined to win some concession on this point. Dalsager, concerned with the increased unemployment if the fish processing factories were forced to shut down, refused that demand. He maintained in televised statements that the Danish fishers have long known that the quota would be filled before the end of the year and that, since they were participants in negotiations which set the quota, they should observe them. The chairman of the Danish Fisheries Association, Soren Knudson, however, responded that the fisheries organizations have not sponsored or encouraged the blockade, but he refused to put any pressure on the fishers to end it. The self-appointed blockade leaders set up an ad hoc organization and were acting independently of the old organization leadership.

Dalsager met 17 November with the Parliamentary Committee on Fisheries and won general support for his position. At that point, it was still impossible to predict the outcome, but the situation was brightening for the Government. The small fishers who fish in the Skagerrak and Kattegat, where the prohibition is not in effect, were anxious to return to sea and were reportedly willing to break the blockade of the larger fishing cutters which fish mainly for reduction fish in the North Sea. On the other hand, the Government had very limited means of physically breaking the blockade and recent labor troubles with blockades by trade unions of individual firms were being cited to prevent police interference. Public and editorial opinion, however, was beginning to run against the fishers and hope was being expressed that the blockade would end soon without causing interference with other shipping services.

According to the NMFS Office of International Fisheries, a ban on herring fishing would have an impact

on the Danish economy. Approximately 3-4,000 Danes fish for this species, and 6-7,000 persons work in plants which process herring for either fish meal or for human consumption. Additionally, the ban would cause the price of herring to rise, and the overall supply would probably be short, since both the Faeroese and Icelandic fishers had filled their quotas as well. However, Sweden, the Federal Republic of Germany, and the Netherlands had not filled their quotas and Danish fishers were exploring the possibility of landing their herring catches in the ports of those countries.

Restrictions on cod and herring fishing would also have an impact in the United States. In 1974, Denmark exported $29 million worth of cod and $0.5 million of herring to the United States. (Sources: U.S. Embassy, Copenhagen; *Politiken;* and *Borsen.*)

Norway Reports Difficult Year for Fish Industry

Last year, 1975, was one of the most difficult for Norway's fishing industry since World War II, the Norwegian Information Service reports. Catches, prices, and exports all fell as a result of reduced fish stocks, falling prices on the international market, and bad weather. This, combined with sharply rising costs, cut earnings in the industry and prompted extensive state aid which will be maintained at least until May.

Norwegian authorities are thus making 325 million kroner in direct subsidies and 125 million kroner in loans available to the fishing industry. Measures financed with these funds include income subsidies covering the first five months of 1976 and social payments and cost support for the whole of the year.

Among other things, a new "cod fund" was to be created alongside the existing fund for herring, and financed by a loan of 10 million kroner. The fund would provide temporary export credits for cod. This, together with 162.5 million kroner being spent in other ways, was expected to be adequate to maintain the cod prices which applied last autumn. A spokesman for the Norwegian Union of Fishermen indicated that the Union hoped for better market conditions next year so that state subsidies could be cut substantially.

Norway's total fish catch last year reached 2,311,684 tons, according to provisional figures from the Fisheries Directorate. This is a drop of 78,549 tons or roughly 3.3 percent compared with 1974. The firsthand value of the catch fell nearly 16 percent from the 1974 record of 2,235.4 million kroner to 1,885.3 million (inclusive of state subsidies). The price per ton fell from 935 to 816 kroner. The export value of Norwegian fish and fish products fell last year by about 400 million kroner to 2,780 million, the Directorate reports.

Statistics also show that Norwegian fishermen had an average net income of 36,636 kroner in 1973, an increase of 16.4 percent compared with the year before. The average industrial wage in Norway in the same year was 37,354 kroner. About 85 percent of the net income of the average fisherman came from fishing, less than two percent from farming or forestry and nearly 13 percent from other income sources, the figures from the Directorate of Fisheries show.

Soviets Reduce Size of Whaling Fleet

Vladimir Tverianovich, senior whale specialist for the Soviet Ministry of Fisheries, announced on 3 November 1975 that the Soviet Union was considerably reducing its whaling effort in the Antarctic. The *Iurii Dolgorukii*, one of three whaling motherships usually deployed in the Antarctic, was soon to be retired, a measure which Soviets felt would contribute to the preservation and conservation of the whale stocks. Two remaining motherships, the *Sovietskaia Ukraina* based at Il'ichevsk on the Black Sea and the *Sovietskaia Rossiia* from Vladivostok, had already started for the whaling grounds in the Southern Hemisphere.

Under the provisions of the International Whaling Commission (IWC), the whaling season is regulated according to species (through a quota system), whaling method, and area. The Soviet Union, Tverianovich said, has faithfully been fulfilling the recommendations of the IWC. Commission observers would be on board the Soviet whaling vessels as well as the usual Ministry of Fisheries inspectors. Research biologists would also be taking part in the expedition to study the status of the whale stocks (Source: *Tass.*)

According to the NMFS Office of International Fisheries, the Soviet whaling fleet has included as many as seven whale motherships, each of which can support 13-20 catcher boats. In 1973, for example, the fleet consisted of five motherships and about 100 catcher boats. In 1975 the fleet was reduced to four motherships and about 80 catcher boats, so the ratio of boats to mothership was still 20:1.

Of the seven motherships, two (*Slava, Aleut*) have been sold for scrap. The *Iurii Dolgorukii*, as mentioned above, was retired in 1975, and Fisheries Ministry officials were trying to decide what to do with her. These three vessels were all constructed in

Soviet whaling motherships.

Name of vessel	Year built	Crew per vessel	GRT per vessel	Area of operations
Iurii Dolgorukii	1926	520	25,400	Ceased operations in 1975
Slava	1929	400	14,800	Ceased operations in 1968
Vladivostok	1962	400	17,200	North Pacific (since 1962/63)
Dalnii Vostok	1963	400	17,000	North Pacific (since 1963/64)
Aleut	1929	120	5,100	Ceased operations in 1959
Sov. Ukraina	1959	540	32,000	Antarctic (since 1959/60)
Sov. Rossiia	1961	540	33,200	Antarctic (since 1961/62)
7 motherships		2,920	144,700	Antarctic and North Pacific
100 Catcher boats	1937-1964	30	840	Antarctic and North Pacific
Total (Est. 110 vessels)		5,920	228,700	Antarctic and North Pacific
Deployed in 1973 (108 vessels)		5,400	208,800	Antarctic and North Pacific
Deployed in 1975 (Est. 84 vessels)		4,280	166,600	Antarctic and North Pacific

the late 1920's and two of them were used for other purposes before being converted to whalers. All more than 45 years old, they were probably due for retirement despite the whale conservation movement.

The four remaining vessels were built in the late 1950's or early 1960's. It is not likely they will be retired in the near future for, even if whaling were completely prohibited, they are also equipped to serve as fish-processing factoryships. Two of the vessels, the *Vladivostok* and *Dalnii Vostok*, are deployed in the Northern Pacific, while the *Sovetskaia Ukraina* and *Sovetskaia Rossiia* continue to operate in the Antarctic. They are on the 13th and 15th Antarctic expeditions, respectively. Details on the composition of the Soviet whaling fleet are shown in the accompanying table.

Canada Signs Pacific Salmon Aid Agreement

The Federal Government of Canada and the Province of British Columbia have agreed to cooperate in the development of plans for a major program to expand significantly Canada's Pacific salmon resources, Environment Canada reports. A memorandum of understanding signed in Vancouver, B.C. last November by the Federal Minister of State for Fisheries, Roméo LeBlanc, and British Columbia's Minister of Recreation and Conservation, Jack Radford, cleared the way for federal-provincial cooperation in the preparation of coordinated program proposals.

At a morning meeting in Vancouver, they agreed to direct their staffs to prepare detailed proposals for a comprehensive salmonid enhancement program. Planning for the program, announced in Vancouver 24 March 1975 by Le Blanc, was already underway, and the federal government had committed more than $1,000,000 for feasibility studies and planning activities last year. Development projects are due to commence in 1977, pending approval of the overall program by the federal Cabinet.

"I am gratified at the positive and enthusiastic response of the British Columbia Government in agreeing to cooperate in the planning phase of this exciting program," LeBlanc said. "Provincial support ensures a high degree of consultation in developing program proposals having such a significant economic effect on extensive areas of the B.C. coastline."

Radford stated that his department has particular responsibilities for freshwater recreational fisheries, but other provincial departments will also have significant interest in the proposed program. In developing streams for fish, some other uses for these streams, such as power generation or irrigation, may have to be foregone. Land management practices may require modification in some watersheds to preserve the stream environment in a state suitable for fish. Radford also said the involvement of various provincial agencies with the Department of Recreation and Conservation would be coordinated by the Environment and Land Use Secretariat.

Glen Geen, Pacific regional Director-General of Fisheries Management for Environment Canada's Fisheries and Marine Service, was named chairman of a steering group responsible for the direction of planning activities. E. H. Vernon, Associate Deputy Minister (Fisheries), Department of Recreation and Conservation, heads provincial representatives in the group.

The program is aimed at significantly expanding the stocks of salmon to increase returns to the commercial fishery to $400 million annually, while greatly enlarging the capacity of the sports fishery which already supports one million user-days of angling. The program also will ensure adequate resources for the traditional Indian food fishery. Achievement of these goals by applying proven enhancement techniques such as artificial spawning channels, hatcheries and fishways, could be attained by about 1990. Costs of the program, financed mainly by the federal government at an estimated $250-300 million, should eventually be recovered in terms of increased returns to the salmon fisheries.

Publications

NMFS Issues Bicentennial Seafood Cookbook Series

A Seafood Heritage from America's First Industry is the first in a new Bicentennial series of booklets produced by the National Marine Fisheries Service featuring fish and shellfish cookery. Recipes range from "Angels on Horseback" (bacon-wrapped oyster appetizers) through "Beer Batter-Fried Fish," "Fish Salad Bunwiches," "Maine Fisherman's Coleslaw," and "Oyster Roast," to a "Tuna Barbecue" and more.

Recipes are conveniently proportioned for 25 persons for the many gatherings—club picnics, family reunions, fund-raisers, etc.— which will be scheduled during the Bicentennial year. Further, the booklet includes entire menu plans, with an eye toward both taste and economy. Along with the menu suggestions, the well illustrated booklet includes historical vignettes appropriate to the nation's first 200 years and its long-time enjoyment of fish. Its historical anecdotes find Henry David Thoreau kindling a small fire to cook a "sweet and savory clam," and vegetarian Benjamin Franklin devising an elaborate rationale allowing him to partake of fresh-caught cod: "I balanc'd some time between principle and inclination, till I recollected that, when the fish were opened, I saw smaller fish taken out of their stomachs; then thought I, 'If you eat one another, I don't see why we mayn't eat you.' So I din'd upon cod very heartily."

The seafood booklets cost $0.80 each and can be ordered from the Superintendent of Documents, U.S. Government Printing Office, Washington, DC 20402. Request Stock Number 003-020-00101-7.

Soft-Shell Clam Harvest, Salmon Diseases Noted

To facilitate an exchange of information between salmon growers and research scientists, the Washington Sea Grant Marine Advisory Program and the University of Washington College of Fisheries sponsored a work-

shop on 17 April 1974 on salmon diseases. The result is **Salmonid Diseases: A Workshop Summary**, edited by Terry Nosho and Ernest Brannon (WSG-WO-75-2).

This 25-page paperbound booklet contains papers on such topics as furunculosis epidemics in Pacific salmon, control measures for vibriosis and corynebacterial kidney disease, viral diseases of North American salmonids and their relation to nutrition, and legal status of using preventative vaccines.

Another recent Washington Sea Grant booklet is **A Review of the Hydraulic Escalator Shellfish Harvester and its Known Effects in Relation to the Soft-Shell Clam, *Mya arenaria*** (WSG-75-2). Authors of the 32-page publication are Michael A. Kyte and Kenneth K. Chew. Though Puget Sound (Wash.) tidelands have substantial stocks of the soft-shell clams, there have been few such commercial harvests. Because little information has been available on the long-term effects of the hydraulic escalator shellfish harvester on the environment, Sea Grant scientists undertook the survey reported in this publication.

Single copies of both booklets are available by mail at 50 cents each for postage and handling from the Sea Grant Communication Services, Division of Marine Resources, University of Washington, HG-30, Seattle, WA 98195. Bulk copy rates are available upon request.

Getting Down to Business in Commercial Fishing

The failure of both large and small businesses can too often be traced to poor management. Commercial fishing is not immune to the problem. Now, **The Fisherman's Business Guide** has been written by Frederick J. Smith for the commercial operator who seeks business management guidance.

The book is divided into three parts: 1) Economic concepts; 2) management tools; and 3) applications. Using the book, one can examine a commercial fishing operation and weigh decisions in aiming for the best returns on labor and capital investments. The author, an associate professor and extension marine economist at Oregon State University, Corvallis, has taught numerous fishery-business related courses from Narragansett (R.I.) to Newport (Oreg.).

In Part 1, the first two of the seven chapters discuss the economic, political, and physical environment within which a fishing business must operate: Fishery Resource Management and The Decision-Making Process. The other five chapters, dealing with economic principles and concepts, include: Business Objectives and Planning; Demand, Supply, and Fish Prices; Fishing Costs and Returns; Maximizing Profit in a Fishing Business; and Coping with Risk and Uncertainty.

The five chapters in Part II examine important tools in successful fishing business management: Management Information; Profit and Efficiency Analysis; Partial Budgeting; Financial Budgeting; and Business Organization. Finally, Part III applies business management to some major fishing business decisions: Selecting a Fishery; Boat Size and Ownership; and Boat Management.

Such often changeable data as ongoing research and tax and resource management regulations are not discussed in the book. A bibliography is provided for reference on these and other fast changing fishery matters. A listing of other sources of information gives the addresses of the various Marine Advisory Services and National Marine Fisheries Service offices.

The 172-page book contains 51 tables and diagrams and is available for $10.95 from the International Marine Publishing Company, 21 Elm Street, Camden, Maine 04843.

Foreign Fishery Books Translated

A limited number of the following publications, translated and printed for the National Marine Fisheries Service under the Special Foreign Currency Science Information Program (financed with Public Law 480 funds), are available for free distribution from the Language Services Division, F43, Office of International Fisheries, NMFS, NOAA, Washington, D.C. 20235.

Biological and Technological Characteristics of Grenadier Family Fishes (Macruridae) of the NW Atlantic, by J. Nodzynski and C. Zukowski, was recently translated and printed for NOAA/NMFS. This Polish publication was issued by the Gdynia Sea Fisheries Institute in 1971. It contains a brief outline of a survey of the grenadier species occurring in the ICNAF fishing grounds of the Northwest Atlantic. Two species in particular, the black and gray grenadiers, have been analyzed from both the biological and technological points of view.

Principles and Problems of Zoogeography, by P. Banarescu was published in 1970 by the Romanian Academy of Sciences Publishing House. Its translation and printing were recently produced for NMFS in Yugoslavia under the Special Foreign Science Information Program financed by PL-480 monies. The book discussed in detail the geographical distribution of freshwater and marine animals. Its eight chapters cover the subject of zoogeography and its relation to other sciences; geographic bases of animal specification; ranges of species and supra-specific taxa; faunas, their component elements and zoogeographical units; role of selection and competition in dispersal of taxa and the formation and evaluation of faunas; paleogeographical theories; problems of reconstruction and evolution of taxa ranges; and problems of zoogeography of freshwater animals.

Introduction to Oceanography and Marine Meteorology, by M. Buljan and M. Zore-Armanda was published in 1971 by the Institute for Oceanography and Fisheries, Split, Yugoslavia. This textbook was recently translated for NOAA by the Nolit Publishing House, Belgrade, under the Special Foreign Currency Science Information Program (financed with Public Law 480 monies). It is made up of two parts. The first one covers marine geology, chemical and physical properties of the sea, motion of the sea, organic production, and related topics. The second part deals with marine meteorology, meteorological codes, the reading of synoptic charts, and meteorological phenomena in the Mediterranean and Adriatic Seas. A brief historical review of explorations of the sea in Yugoslavia and other parts of the world is also presented. The volume includes a glossary of oceanographic and meteorological terms and a short bibliography.

A Fish Disease Lab, and Fisheries and Oceanic Expositions

....**Ground was broken for a $4 million fish disease laboratory** at Leetown, W. Va. on 20 December by the Interior Department's U.S. Fish and Wildlife Service (FWS). The 2-year expansion program, tripling present space to 30,000 square feet, will make the Eastern Fish Disease Laboratory one of the most modern fish health research facilities in the world, the FWS reports. The two-story lab will feature solar heating, and the FWS will be able to combine fish husbandry training schools with the existing Leetown school of fish diseases....

....**The Law of the Sea Institute tenth annual conference** is scheduled for 22-24 June 1976 in Kingston, R.I., the institute reports. Its theme will be "Law of the Sea: Projections of Implementations." Further information is available from The Law of the Sea Institute, University of Rhode Island, Kingston, RI 02881....

....An international symposium on **the "Ecology and Management of Some Tropical Shallow Water Communities"** will be held 27 June-11 July 1976 at Jakarta and Ujung Pandang Island, Indonesia. Sponsored by the Western Society of Naturalists and Indonesia's Institute of Sciences, the meeting is being held to learn more about the ecology of shallow water communities in order to develop plans for a rational use of their resources. More information is available from David H. Montgomery, Secretary, The Western Society of Naturalists, Biological Sciences Department, California Polytechnic State University, San Luis Obispo, CA 93047....

....**U.S. Coast Guard rescue units may "bag" sinking boats** in the future with newly developed Emergency Flotation Bags (EFB's). Distributed to many Coast Guard units, the large inflatable bags are designed to supplement the dewatering pump kits already used to assist sinking vessels. One or more of the EFB's stuffed into empty compartments or lashed to the hull provides the buoyancy needed to get the distressed boat towed to safety....

....**The 1976 Australian Fisheries Exposition will be staged** in Melbourne, Australia 21-23 September 1976, with a three-day fisheries seminar to be held in conjunction with it, according to *Australian Fisheries*. More information on the Expo is available from the Convenor, Australian Fisheries Exposition, GPO Box 2246U, Melbourne, Victoria, Australia 3001....

....**A 26-inch minimum size limit for sport-caught king salmon** has been set for Southeastern Alaska by the Alaska Board of Fisheries according to the Alaska Department of Fish and Game. The new minimum size limit applies in salt water from Dixon Entrance to Cape Suckling and undersize kings must be returned to the water immediately....

....**Planet Ocean, a permanent ocean science exposition** in Miami, Fla., was opened to the public in mid-December, the International Oceanographic Foundation reports. The $6 million ocean environment center has been named by the American Revolution Bicentennial Administration (ARBA) as one of only 11 projects in the country in the Horizons 76 program. Some of the exhibits include a 7-foot iceberg, working models of tidal power stations, exhibits of hydrogen fuel energy, submarines, ship models, and other film and slide presentations....

....**Fear of shark attack by South Australian abalone divers** is blamed for an abalone catch decline in recent years, *Australian Fisheries* reports. Several divers are now working on various self-propelled underwater shark-proof cages. If effective, the Abalone Divers Association expects that catch effort and diver confidence will both rise, and that most working abalone divers in South Australia will eventually be protected by such cages....

....**Two more Liberty Ships may be added** to California's Santa Monica Bay artificial reef if another such vessel, sunk there last spring in a pilot project, succeeds, the Department of Fish and Game reports. A $75,000 limit has been set to fund the program. The second and third vessels are set to be sunk 3½ miles from Channel Islands Harbor, Ventura County, and 6 miles from Newport Harbor, Orange County, respectively. California has built 10 offshore ocean and Salton Sea reefs and pier reefs to improve marine habitat and promote fishing....

....**December's 3 million-pound coastal crab catch** gave Washington State crab pot fishers their best opening month in four seasons, the Department of Fisheries reports. The large catch was credited to an unusual number of fishing days. Good weather and sea conditions enabled crabbers to check their pots as many as 21 days. More frequent lifting and rebaiting of pots reduced crab losses and tended to improve landings in both quantity and quality, state officials noted....

....**Australia's marine product export value hit $71 million,** during the 1974-75 fiscal year, exceeding exports by $175,000, according to *Australian Fisheries*. The total was almost $2 million over the previous 12-month period. Edible marine products were valued at $68.2 million versus imports of edible fish products of $61.7 million. Rock lobster tails were the most important export, as the value increased from $25.8 million in 1973-74 to $32 million, and the quantity rose from 3,784 to 4,193 metric tons; the United States remained the main market. Cultured pearls, at $1.5 million, was the main inedible fishery product....

....**Japan now has 155 vessels fishing for squid off New Zealand,** according to a *Suisan Keizai Shinbun* report. As last season, the fishery runs from 1 November to 30 June. Japan's squid catch during the previous season was 18,224 metric tons by 151 vessels....

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